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AN EXPEDITION TO THE GILF KEBIR AND 'UWEINAT, 1938

Evening Meeting of the Society, 23 January 1939

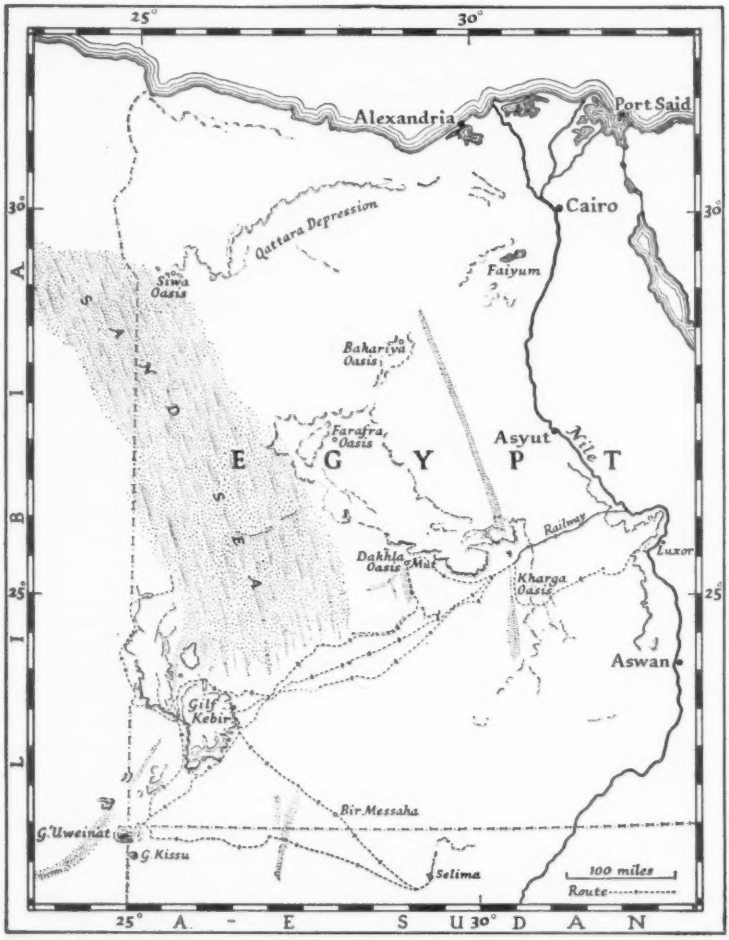
1. NARRATIVE OF THE JOURNEY. By Major R. A. BAGNOLD

MY original object in instigating this expedition was to verify in the field, with the aid of a grant of money provided by the Royal Society, my previous experimental work on dunes and sand movement. The neighbourhood of the Gilf Kebir seemed an ideal spot for my purpose; not only is it generally held that sandstorms are more frequent in the west and south-west than elsewhere in Egypt, but this area I knew to lie on the type boundary between the vast seif-dune ranges of the Sand Sea in the north, and the barchan fields to the south and south-east, and to contain very interesting transition types.

In order that as much useful information as possible may be got out of an expedition to such a hardly accessible spot, it was clearly proper that specialists in other subjects should be included. Incidentally, by increasing the size of the party a considerable saving in the cost of transport could be effected. The Egypt Exploration Society took advantage of this opportunity, with the result that, through the generosity of the late Sir Robert Mond, I was joined by a party consisting of Mr. O. H. Myers, Mr. T. Gray, Dr. H. A. Winkler, a mechanic, and three Qufti excavators. For my part I was fortunate in having as my companion Mr. R. F. Peel, of King's College, Newcastle, to whom are due among other things the successful navigation of the expedition and the geographical results obtained. The expedition was thus a joint one consisting of the Egypt Exploration Society's party on the one hand, with two cars, and Peel and myself on the other, with but one car, each party being financially independent of the other.

The Gilf area is completely waterless, the nearest wells being at Bir Misaha (Messaha) and 'Uweinat, nearly 150 miles away; but with reasonable care the consumption of water can be made so small that a single initial supply can last a party for several weeks. As before, supplies of petrol and preserved food were sent in advance to Selima Oasis by camel from Wadi Halfa by the Shell

Company of the Sudan, and we are grateful to Mr. Purves, Governor of the Northern Province, and to Mr. A. C. Walker for their assistance in ensuring its safe arrival. The supplies included a number of new empty 4-gallon petrol containers for canning the excellent water of the oasis for our use at the Gilf.



Sketch-map showing the routes to the Gilf Kebir

The combined party left the E.E.S. camp at Armant near Luxor on 5 February 1938, and drove direct across the limestone plateau to Kharga Oasis, descending the cliffs of the depression by a new pass recently opened by the Egyptian Frontiers Administration. After a day spent in collecting

supplies of fresh food which Muhammad Wasfi Bey, the Governor, had kindly arranged for us, we set out for the south-west, following more or less my old route of 1932. This route, while by no means the best, lies for a long distance through a chain of ancient lakes or mud-pans of which the only remains now are strange groups of sitting sphinxes, or "mud-lions," occupying the bottoms of shallow depressions. This area is one nearly continuous neolithic [1] site, dotted everywhere with querns, grinders, implements, and the ashes of ancient hearths. It is now of course as barren as the rest of the sandstone plain, with not a vestige of vegetation.

On the second day the dark cliffs of the Gilf plateau appeared along the western horizon, headland after flat headland like some forbidding coast line. It was here, on the east side of the southern part of the Gilf, that we proposed to make our camp for the first month. A suitably sheltered spot was found underneath the 1000-foot cliffs, conveniently near to a likely neolithic site for Myers and his party and to a line of dunes for my own work. Myers and his three workmen were left marooned here with all our dumped stores while the rest of us went with all three cars to Selima, 250 miles away across the sand-sheet, to lay in further large supplies. Calling *en route* at Bir Misaha, dug by Mr. H. J. L. Beadnell for the Survey Department in 1927–28, we found that the report we had received in Cairo of its having become sanded up was unfounded, though the decay of the lowest timbers may at any time allow a small collapse of rock to make the well temporarily unusable. Both Peel and I were lowered to the bottom 220 feet below the surface, I for mere curiosity, and Peel to retrieve a light rope we had accidentally allowed to fall. In spite of the well lid being permanently shut down to keep out the drift sand, the air in the well, though hot and sulphurous, is perfectly good, as also is the water at the bottom, once the decayed wood and dead scorpions have been filtered out of it.

Returning to the Gilf dump, which Myers had in the meantime turned into a smart camp, we found that a remarkable change of outlook had taken place. The camp lay not as expected among the remains of early neolithic folk of perhaps five thousand years B.C., though such remains were there too, but was instead away back in the dim past of three hundred thousand years ago, in the midst of a large settlement of Acheulean man.

For the next few weeks, while I was mainly occupied with observations among the dunes, Myers and his party were at work on the past. Peel with my car and accompanied by Gray, and on windless days sometimes I alone, traced in turn the courses of each of the long winding gorges which penetrate westwards into the massif of the Gilf. These we found to contain much live vegetation (though no trees) and many ancient sites. For a long time the unexplored top seemed totally inaccessible except on foot. From El 'Aqaba in the north-west, southwards down the western coast, and northwards again along the eastern cliffs, including the outline of the walls of all the "creeks" and "fjords," we estimate a total cliff frontage of more than 2000 miles; yet so uniform is the structure of this extraordinary tableland

[1] It is at present impossible to distinguish between the late Upper Palaeolithic and Neolithic of Capsian origin in this area. Throughout this article "neolithic" has been used to designate the sites of this doubtful period where no pottery was found.

that we despaired of ever finding a way up possible for a car. On February 28 however Peel and I succeeded in finding a very tall sand-drift some miles north of our camp which yielded to us after four unsuccessful attempts to charge it at speed with our car empty. We found ourselves at the tip of a small peninsula connected to the mainland of the plateau by a narrow neck along which ran a well-beaten road marked at close intervals by ancient cairns. We had unwittingly hit upon a forgotten pass probably last used by the Stone Age people when the lifeless yellow plains below were green. On March 3 we went up again, and spent two days travelling over the plateau and across to the brink of the western cliffs.

A proper survey of the top was peculiarly difficult; for although the positions of the more important headlands had been fixed from below, from a distance, by Prince Kemal el Din on the east and by Clayton on the west, yet so flat is the land above that a few hundred yards away from the cliffs all landmarks visible from below disappear from view, and one is left with a flat horizon broken only by the domes, far away in the interior, of isolated unmapped basalt hills sticking up through the mirage. Indeed, unless one stands on their actual brink, the presence of the cliffs can only be inferred from the peculiar lack of whiteness in the hard sky of the horizon.

Upon the top the Gilf forces on one the complete illusion of a large cliff-girt island rising from mid-ocean: the endless succession of headlands all of even height, the cliffs beneath them falling sheer from the flatness of the tableland without preliminary drainage slope, the limitless plains 1000 feet below, so far down that their negligible yellow features fade away in the haze. Even more striking is the monotonous shouting of the wind that sweeps continually over the plateau and swirls away into space over the edge of the cliffs: nothing could better imitate the roar of breakers on a distant beach. Another odd fancy was the imagined presence of the old people. There was nothing between them and us. The place has the utter remoteness of another world. One felt suspended high above the desert below, itself many hundreds of miles from the nearest habitation. The plateau is a harsh barrenness of broken rock; over all its thousands of square miles we found but two or three tiny dells containing vegetation, yet a network of paths cross and recross it. Lines of stones are laid out in curious patterns as if by children playing at forts. Implements and flakes are everywhere; near the cliff edges the ground is literally strewn with them, some blackened by the sun, but others so fresh they might be yesterday's chippings. One expected at any moment to see the return of their makers, uncouth figures clambering up over the skyline of the cliffs hammer-stone in hand to resume their eternal rock-breaking.

On March 5 the rest of the party left for Kharga, 300 miles away, to bring out more fresh food and petrol. While they were away I spent a very pleasant eight days alone in the Gilf working up the results of my measurements and waiting for another sandstorm. Each evening the solitude was broken by loud and deep-throated talk coming from far up in the sky where, on their leisurely migration northwards to the African coast, flights of cranes circled and recircled while waiting for their laggard friends. Farther south, just east of 'Uweinat, we found flights of these great birds rallying daily some three hours earlier in the afternoon.

Nubian sandstone country north-east of the Gilf Kebir

Ancient tracks on top of the Gilf

The Gilf cliffs

Wadi el Bakht near its head

Dune ranges, about 150 feet high, at the southern end of the Sand Sea

Cliffs behind the Base Camp. The detritus shows the stream beds of the last rains

A heavy sandstorm came conveniently for me on March 6, and my anxiety lest our camp should be engulfed by the neighbouring dune was countered by the satisfaction of getting some really reliable measurements while the storm was at its height. It was accompanied by a great deal of hooting and booming on the part of our dune. Maybe the sand which blows over the Gilf is peculiarly prone to hooting—I will not call it singing, for the note is too low and pure—but we heard it on three occasions. One night when Peel and I were camped in El 'Aqaba in a narrow space between a big drift and a rock cliff it came on suddenly, breaking the silence of a still evening with a sound so loud we had to shout to one another to be heard. The whole valley vibrated with it for five minutes on end. Afterwards I imitated the noise quite easily, in a small way, by scrunching the butt-end of a whisky bottle in the sand.

The others returned on March 12 along a new route slightly farther south than any used by previous travellers, by which they avoided all the broken country and made very good going over fast sand-sheet all the way. We struck camp next day and moved south-west towards 'Uweinat, where Myers and Winkler proposed to spend a couple of weeks, the former looking for pottery and the latter for rock-engravings and paintings. On the way Peel noticed, and we all went and inspected, a large group of volcanic craters very similar to, but farther to the north-east than, those found by Clayton in 1931. We camped in the bed of Karkur Talh, at 'Uweinat, about 9 kilometres from its mouth, surrounded by the scores of rock-pictures which adorn the sandstone cliffs of the valley. The same evening Myers, Peel, and I left on a second journey to Selima for the remainder of our petrol. For the first 100 miles of the journey over the great plain we drove through site after site of ancient remains. Farther east, if they exist, the growing sand-sheet has covered them up. We also passed a large flight of cranes resting on the sand like a party of tourists on a beach. There were many single birds too, from other migrations.

As by far the best route to 'Uweinat from the Nile is *via* Selima, it may be useful to mention that the heavily used road marked out by the Sudan Government with petrol tins is by far the worst; it should be avoided at any rate for the 50 kilometres west of Selima. After experience of several routes I am convinced that the best is that found for us by Newbold in 1930, which strikes out due west after following the bones of the Arba'in track for not more than 12 kilometres.

Peel and I stayed a day or two at Karkur Talh, and then drove round to Karkur Murr at the south-east corner of the mountain. At the uppermost end of this valley upon the saddle dividing it from Karkur Talh and close to the foot of the great eastern bastion of the main massif I came upon a cave containing a new and interesting group of rock-paintings. The find releases this valley from the stigma of being the only source of water and grazing at 'Uweinat without its painted cave. Lower down, the water-holes which our party saw in 1930 are now much altered in appearance. There is far more water; in places it resembles a chain of moorland pools. While peering into the dark doorway of one of the deserted barrack huts built by the detachment of the Sudan Defence Force in 1934 I was all but knocked down by a very

fine specimen of wild sheep (*waddan* [1]) which came rushing out of the hut in alarm. As he trotted away I saw that his mane of chest hair reached to the ground, trailing between his forelegs. It has recently been said in Cairo that these animals were extinct at 'Uweinat, but we saw many. Indeed, at Karkur Talh the wild life was abundant, and *waddan*, gazelle, and foxes began after three days to take little notice of us. We then drove across to Gebel Kissu, where we spent an interesting day making what I take to be the first ascent of its main granite peak. The plain between the two mountains was full of gazelle, and by the state of the vegetation there must have been heavy rain not more than two years previously. The mountain plants on Kissu were all in full flower.

On March 19 Peel and I set out northwards from 'Uweinat, along the plain beneath the western cliffs of the southern Gilf, past El 'Aqaba and on up the side of the northern Gilf as far as the Cufra–Farafra camel route; thence, following it eastwards up the pass of El Gubba, to Clayton's former camp in the silica-glass area near the southern extremity of the Sand Sea, the dunes of which I had not seen for eight years. I wanted here to look at the particularly interesting transition forms taken by the dune ranges. The country, as everywhere in the Sand Sea, is dead flat. It consists, like the surface of the Gilf into which it merges towards the south, of black boulders of flint-hard silicified sandstone. In contrast with this harsh black floor the parallel ranges of pale dunes, rounded and filmy, seem very unsubstantial. At midday the lanes between them, 2 miles wide, are filled with mirage, through which the dune peaks 200 feet high rise like the sails of unending lines of yachts. Later the mirage goes; the peaks, now of deep gold, join up into continuous walls that run on and on, straight as rulers, side by side to a serrated horizon. The silica glass, a geological enigma, lies about in greenish-yellow lumps glittering in the sun. Some of it is opaque, but most of the fragments, especially the smaller ones, are completely transparent; they might be bits of gem-stone. Like the Gilf and its surroundings, this part of the Sand Sea is littered with palaeolithic and neolithic remains. The glass was much worked during the latter period.

After two days here we returned on our tracks westwards and southwards to the pass of El 'Aqaba, which had been agreed upon as a rendezvous with Myers's party for April 1. On the way we visited the painted caves found by Almásy in the western cliffs at his Wadi Sura (lat. 23° 33′, long. 25° 16′, about 3 kilometres south-east of the spot marked "rock pictures" on the Egyptian 1/500,000 map).

Having still some days in hand, we left a message at El 'Aqaba, as we had done at other places along our route in case we should become stranded with our one car and should need rescue, and drove up from the top of the pass (which enters a broad lane of lower level that cuts the plateau into two halves) on to the tableland of the northern Gilf, with the object of visiting the Wadi Abd el Malik, to look for the well which the old man Abd el Malik has assured Almásy was there. There being as usual in the Gilf no possible way down for cars from the plateau to the valleys within it, we had to climb down and walk. We walked a total of more than 30 miles along the soft sandy floor

[1] Erroneously called *moufflon* by some French and other writers.

of that wadi, during two stifling days when a *khamsin* wind was blowing from the south. The trees were green, and the xerophitic grasses and scrub were in full flower, but although we came upon the *heglig* trees mentioned by the old man, we failed to find any other evidences of the well. We were however rewarded by Peel's discovery of yet another painted cave.

While returning over the boulders of the plateau top the day before our prearranged meeting with Myers at El 'Aqaba, our car expired suddenly from a broken back axle-shaft. As with this disablement it could not even have been towed, there was no alternative but to abandon it and walk.[1] So, strapping a 2-gallon can of water on our backs together with some food, we set out on foot over the rocky cliffs to the rendezvous, which was fortunately not more than 25 miles distant. We had left the others but ten days before and only 140 miles away at 'Uweinat, but as none of them had ever been up the western side of the Gilf or seen the rendezvous, and as without transport there would have been no hope of walking to anywhere useful in this world, we were relieved at finding them waiting for us.

It was bitterly cold the night of our arrival. Myers had found an excellent camping-place in the side of a collapsed hill where there was good shelter from the wind and soft lying on beds of drifted sand beneath the huge blocks of fallen rock. Perhaps for me the most lasting memory of the expedition will be the finding of an artificial ledge in the dark recess of one of the caves, and on it a stone knife left behind untold centuries ago by the last occupier, just as we ourselves would empty our pockets before going to bed.

After collecting with one of the remaining cars all our gear from the wreck, we set out north-eastwards through the gap in the Gilf on an uneventful run to Dakhla Oasis and the Nile.

In conclusion, I should like here to thank, on behalf of Peel and myself, the Council of the R.G.S. for their grant of money for our side of the expedition and their loan of instruments; Oliver Myers for his active cooperation and the services both of his excellent mechanic, Hagob Palamoudian, and of his three cheerful Egyptian assistants; and to acknowledge with grateful memory the help and encouragement we all received from the late Sir Robert Mond.

2. THE SIR ROBERT MOND EXPEDITION OF THE EGYPT EXPLORATION SOCIETY. By O. H. Myers

When Major Bagnold suggested that we might make a joint expedition into the western desert, he to study sand, and we to study archaeology, it so happened that the scheme coincided with some research upon which we were engaged connected with Saharan pottery. The proposal was put to Sir Robert Mond, who at once saw the importance of the research, and with his never-failing generosity financed this further archaeological venture. Many expeditions have collected material from this area, notably that of Mr. W. B. K. Shaw in 1935, but there were two outstanding differences

[1] The car has been recently located, repaired, and brought back by Muhammad Wasfi Bey. Since the exploits of Prince Kemal el Din, this expedition of his is probably the most difficult to be accomplished entirely by Egyptians.

between our own and those of our forerunners; we had certain specific objectives, and we proposed to excavate, albeit on a very small scale. We therefore brought with us two cars in order to carry workmen and archaeological impedimenta. Our part of the expedition was made up of myself, Mr. Terence S. Gray, M. Hagob Palamoudian (chauffeur-mechanic, who also aided us in every possible way), and three native workmen, a man and two boys, who carried out their duties excellently. For the second month Dr. Hans Winkler joined us to copy rock-drawings.

Before describing what we found it is necessary to state the problem posed us at Armant, which made it worth our while to undertake the expedition.

As long ago as 1929 we began finding on the surface of the desert edge certain sherds which did not seem to belong to any known Egyptian culture. It was not until 1934 that we began seriously to investigate the matter, and after considerable research discovered identical pottery from various places in the south-western and south-central Sahara. We were given every opportunity to study these by the Direction of the Musée de l'Homme in Paris. On the return of the expedition to Armant in the autumn of 1935 we tried to discover more about this curious intrusion of a Saharan culture in the Nile valley. For part of that season and the next our efforts were singularly unsuccessful, because we were trying to find either the cemeteries of these people or a settlement with some depth, and neither existed. Last season however we adopted a new technique of sieving the surface in all places where Saharan pottery was found and collecting all the sherds, flints, and other objects for statistical study.

By this new approach we rapidly achieved results. First, we were able to piece together complete and semi-complete pots which, as Mr. W. B. Emery pointed out, bear close resemblances to the early C-Group of Nubia, which may be dated to about the VIth Dynasty. At the same time it was possible to prove statistically that the Saharan sherds were related to a sealing-wax-red ware of Egypt made between the IIIrd and the VIth Dynasties. A few beads indicated the later date. A small expedition to the north as far as Farshut could find none of these sherds north of our concession, whereas one to the south as far as Edfu found examples all the way, and it seemed safe to assume that these people came in during the VIth Dynasty either from the west or the south, probably the latter. We set out with the idea of seeing if traces of this Saharan people (or of any other earlier invaders) could be found due west and of filling in some points in the huge gap between Armant and Gebel Silto (near Bilma, west of Tibesti), the nearest spot from which the same pottery had been recorded.

The results were extremely satisfactory. Identical pottery was found at 'Uweinat in the south, and none north of this. It seemed abundantly clear that the great stretch between 'Uweinat–Gilf Kebir on the one hand and Kharga–Dakhla on the other was already closed by desiccation at this date (*circa* 2500 B.C.). There is an area of dunes connecting the 'Uweinat area with that of Erdi and Ennedi, and this would be passable after sufficient rain as it would provide grazing. The area is well covered with ancient sites (not examined by us), and it is well known that tribes to-day can travel over dune areas after rain when other areas are impassable. It seems probable that the

'Uweinat group were an offshoot of the main emigration, and that they either stopped there or went across to the Nile *via* Bir Tirfawi and Sheb, where there is a large area only a few feet above the present water-table. The main route might have been *via* Erdi, Merga, Laqiya, Selima to Wadi Halfa, but more probably it passed farther south still, as Frobenius found C-Group pottery in Wadi Hawa. Through Wadi el Melik (not to be confused with Wadi Abd el Malik in the Gilf) to Ed Debba is an extremely likely route, for as late as the Meroitic period it was in constant use. Dr. Grabham has seen extensive Meroitic remains at the head of the wadi, including sandstone columns. This result therefore supported our hypothesis that the migration route was along the south. Indications were also found that this culture belonged to the most recent of the rock-drawings at 'Uweinat (those done in white only), but our small staff, and the fact that two-thirds of it were ill while we were at 'Uweinat, prevented our obtaining proof.

In the Gilf Kebir a similar pottery was found, though nothing exactly comparable with the Egyptian material; some of the sherds appear to be identical in decoration and shape with the large campaniform vases of Spain, which began there at 2500 B.C. In this respect it is worth noting another fact, that the first appearance of the Temehu Libyans in Egyptian history is in the reign of Pepy II, VIth Dynasty. Before describing briefly the other finds, it is worth summarizing the very important results of the above work.

At the First International Meeting for the Study of the Archaeology and Quaternary Geology of the Sahara, held in Paris in the last days of June 1938, the Armant material was submitted to the experts of the French Sahara, who agreed unanimously that it was Saharan. As a result we are now in a position to state that the C-Group people (and the Armant invaders) were of Saharan origin sharing a culture common to all that vast area (Weigall and Reisner both suggested a Libyan origin for the C-Group people), and that they entered Egypt about 2500 B.C.; that Saharan influences seem to have reached Spain at the same time; and that we may therefore assume a final exodus from the central Sahara at that date. A guess may be made as to the reason for this. Desiccation must have set in gradually, and even after modern weather conditions had become general food supplies would not all at once become exhausted. Much humus would remain and many more seeds would be lying dormant. The lake areas would only slowly dry up, and population by becoming nomadic could continue to exist for a considerable period in certain areas. However the first extensive period without any rain would make life impossible. A freak period of say seven years with no rain would make emigration essential. Perhaps this took place at about 2500 B.C. and the last pulse action of the Sahara was thereby caused, affecting cultures as remote as southern Europe and Nubia, and perhaps even farther. For the origin of this people we can perhaps look to the lake areas explored by M. Théodore Monod, where he found harpoons in quantity, hippopotamus bones, etc. The pottery, though little of it is basket-made, appears to have this process as the background of its decoration. Pottery is not naturally to be expected in a highly developed form from Badawin, but could well originate among marsh dwellers. The results are not only important for students of early European and Egyptian history but also for Saharanists, since cemeteries of

the early periods have yet to be found in that area and they will be able to derive much information from the extensive publications of Nubian C-Group graves.

Apart from pursuing the important primary aim of our research, we made such excavations and observations as we could on any archaeological material that came our way, though we did not touch any site without attempting something in the nature of scientific work.

Nearly three weeks were devoted to the clearance of an Acheulean surface site with instruments *in situ*. An area of 25 metres by 30 metres was completely cleared and all artefacts collected. Before moving any of the implements they were all marked with an arrow indicating magnetic north. It was soon clear that the majority of the instruments had not shifted and that the main winds had been steadily from the north since the instruments were left. Many interesting climatic and geological questions were raised by this site and neighbourhood, but they cannot be gone into until experts on these subjects have been consulted.

Throughout the entire area covered sites were found yielding instruments, ostrich shell, ostrich-shell beads, querns, and grinders. These might be either late Upper Palaeolithic or Neolithic of Capsian origin. In any case they preceded the general use of pottery in that area. One site was found between Kharga and Armant. It is clear that at this date communication was open across the whole area, and it seems probable that, when it dried, the people evacuated it in different directions, many probably clustering in the lake areas mentioned above and originating the pottery culture of the later period. Mr. R. F. Peel describes below a large number of these and other sites which he observed on the plateau of the Gilf and elsewhere.

The areas with pottery were those in which special circumstances prevailed and obviously at a period when existence in the vast part of the area was impossible. Apart from the sites at 'Uweinat, two were investigated in wadis in the east side of the Gilf. The wadis had been stopped by dunes, allowing lakes to collect, and it was here that a rather poor existence became possible for these people at this later date. The period is probably either contemporaneous with the Armant people or a little earlier. It is curious that they made no rock-drawings or paintings. Instruments were present in enormous quantities, mostly in quartzite, except for the microliths in quartz and chalcedony. Querns, grinders, ostrich-shell beads, and sherds were all plentiful; two or three examples of carved stone were found, two large spoons, and a phallic object. In each site, one or more squares were sieved and the entire material therefrom brought home for study, as well as the more important material from the site. No graves were found. Quantities of small rings of boulders and stones were found, the purpose of which was not discovered. These may have been dwellings, but some were perhaps used for exposing the dead, though the C-Group people did not have that custom. In some cases more than one level of implementiferous detritus was found.

At 'Uweinat we were able to show that the cultural material connected with the rock-drawings was still *in situ*, and a scientific excavation of a dozen of each type of site would, by statistical method, certainly tell us the connections of the different groups of artists with the different groups of implement and

pottery users. We could not go further with the research for reasons stated above. One splendid site found in Karkur Talh, with fine crystal blades and a spindle whorl, was left intact, as there was no time to work it properly and we had no wish to rob it of its most significant objects.

There is no place here to go into the details of the finds, which will be published fully later,[1] but one other result must be mentioned. Near the Acheulean site was a filled-in lake bottom with a neolithic site on the surface. Excavation showed layer after layer of alternating sand and mud representing the alternating wet and dry periods. Further excavation in similarly sheltered sites should give us the connections of the different cultures with these periods.

We are deeply indebted to Major Bagnold for the trouble he took in planning the navigation, transport, etc., of the expedition, and to Mr. Peel for making maps for us and giving other help. Also to Mr. Gray for giving his services to the expedition and for taking a most valuable series of photographs. Nor can reference be omitted to the splendid way in which M. Palamoudian helped us on every occasion in all departments as well as his own, nor to the exemplary behaviour of the Egyptians transported into the midst of the hated desert, who did their work and looked after our comfort with unfailing good-humour. I wish to express my personal thanks to the late Sir Robert Mond, who gave me this opportunity of exploring the innermost part of the desert on the edge of which we have worked for so long, and to Major Bagnold for allowing our expedition to join with his and therefore gain the help and advantage of his long experience in desert travel and navigation.

3. ARCHAEOLOGY. Additional Notes by R. F. Peel and R. A. Bagnold

It is not in the province of the authors, neither of whom can claim expert knowledge of archaeology, to comment upon the important conclusions drawn by Mr. Myers from the work done by himself and his companions on the expedition. The very nature of the problems upon which the archaeologists were engaged however necessitated their concentrating attention upon a small number of selected sites. We, in the course of exploring and surveying the Gilf and its neighbourhood, wandered much farther afield, and had the opportunity of seeing a large number of sites which the experts could not visit. The following notes are intended to supplement Mr. Myers's account by giving a brief and necessarily non-technical description of these additional sites.

Palaeolithic sites

The palaeolithic sites discovered were few in number but widely scattered. The combined expedition discovered palaeoliths on the limestone plateau between the Nile and Kharga, lat. 25° 17′, long. 32° 02′; on the edge of a large shallow depression some 60 miles east of 'Uweinat, lat. 21° 52′, long. 26° 11′; and in large numbers at the Acheulean site near the Gilf base camp (*vide* Myers, *supra*, p. 290). In addition, Bagnold and Peel noted palaeoliths of similar types in one or two of the wadis near the Gilf base camp; on the

[1] Mond, Sir Robert, and Myers, O. H., 'Cemeteries of Armant II and a Saharan culture,' Egypt Exploration Society, London. (In preparation; due 1940.)

Gilf surface near the western cliffs, lat. 23° 18′, long. 26° 02′; at the camp in the south of the Sand Sea, lat. 25° 17′, long. 25° 34′; and in the upper part of Wadi Abd el Malik.[1]

The majority of these sites are grouped round areas of higher land, and none was found on the open sand-sheets. This distribution would appear to support Sandford's contentions of 1933[2]: "Palaeolithic implements are liable to occur almost anywhere in the Libyan desert, but there are certain wide areas where they are most unlikely to occur, from which indeed they appear to be completely absent. These areas are the sand-sheets . . ." And again: "As a rule height seems to have been favourable to Palaeolithic man . . . Ground that is high, or adjacent to some elevation, may reasonably be expected to bear implements." It must be pointed out however that nearly all our time was spent round the Gilf and 'Uweinat, and the sand-sheets were traversed at high speed with little opportunity of looking for implements.

Later sites

Far more frequent were sites later than Lower Palaeolithic. The most frequent objects they contain are flaked stone tools of a wide variety of types. Many also contain querns and grindstones, and ostrich-egg shell, sometimes decorated and worked into beads, is associated with a large proportion of such sites, particularly those out on the plains. Polished stone tools are rare, but a few were found by Myers, and one or two noted by the authors.

Sites of these types are exceedingly common. They exist over most of the area covered, but there was a concentration of quern sites in the more broken country, where eroded mud deposits frequently gave evidence of the former existence of lakes or marshes. At least a dozen such sites were seen at the feet of the scarps between Dakhla–Kharga and the Gilf. They were common also round 'Uweinat, but most abundant in the wadis and depressions round the Gilf. Myers has described later sites in two of the wadis (Wadi el Bakht and Wadi Ard el Akhdar) on the east of the Gilf, where there was also pottery. Sites without pottery were found in a large percentage of the wadis of the southern Gilf. More surprising was the discovery of similar sites in great profusion on the Gilf surface itself. At a large number of points on the plateau, particularly near its edges, and near the heads of wadis, the ground was literally covered with discarded flake tools and waste flakings. It would appear that the dwellers in the wadis periodically ascended to such points to flake implements out of suitable exposures of the upper silicified beds, and even occasionally out of basalt. Evidence of more lengthy occupation was found round many of the shallow depressions in the interior of the plateau, where querns and rubbers were numerous. Traces of mud in some of these depressions indicate that vegetation may have flourished after rains even on these now barren heights and allowed of temporary occupation.

Two sites near the western cliffs contained large numbers of microliths, and one coup-de-poing was found in this region.

[1] Neither Myers nor ourselves noticed a single Upper Palaeolithic implement throughout the trip, and it seems to be generally agreed that the Libyan desert was uninhabitable during this period.

[2] Sandford, K. S., "Past climate and early man in the southern Libyan desert," *Geogr. J.* 82 (1933) 219–22.

Basalt hills on the surface of the Gilf

General view of crater A3

Stone circles on the surface of the southern Gilf

Wadi floor from the plateau, showing the stream beds

Eroded bed of former sand-drift lake at the head of Wadi Ard el Akhdar

The painted caves of Wadi Sura

Sites with flaked stone tools were also found in fair numbers on the northern plateau, and a wide variety of implements in the upper part of Wadi Abd el Malik; lower down they were entirely lacking, probably on account of a later covering of water-borne deposit. Querns, flakes of many shapes, and one coup-de-poing were found, and one example of a beautifully worked implement of laurel-leaf shape, about 5 inches long.

Apart from artefacts, the Gilf surface showed some other features of interest. Stone circles, built of a single row of flat stones, and some 4–5 feet in diameter, were noted at three points. Similar circles were also found on the top of an isolated hill some 25 miles north-east of the southern Gilf. No obvious purpose could be assigned to these constructions. Still less explicable were certain irregular lines of stones laid out on the plateau surface. They may relate to the many well-defined tracks winding over the plateau, since in nearly all cases they are laid across the tracks as if to mark boundaries of some kind. The general impression gained is that the plateau was visited frequently, if not inhabited, up to neolithic times.

Implements of the types described were also found at intervals along the route north along the western side of the Gilf, and in the Sand Sea area to the north. The open ground of the "streets" between the dune lines abounded in flake tools and querns, and one palaeolith was found. Long curved blades of a type common among the dunes south-west of 'Uweinat were found on the flanks of the dune ridges. The silica glass had also been worked in many places, and a site containing glass and stone flakes was found in the heart of one dune ridge. It is noteworthy that remains other than palaeolithic were concentrated towards the dune ranges and away from the open rocky streets, and that herbage still grows in places after rain on these dunes, whereas there are no traces of any vegetation on the desert floor.

Rock-drawings and paintings

The well-known rock-engravings and paintings of 'Uweinat were intensively studied by Dr. Winkler, and a full account of his work will be published elsewhere.[1] Dr. Winkler also visited the series of paintings discovered by McEuen and Shaw in 1935 in the southern Gilf.[2] At 'Uweinat Winkler found new sites in Karkur Talh, and Bagnold a fine series of paintings in abris at the head of Karkur Murr. Cattle and various groups of human figures were shown in dark-red and white. Subsequently the authors visited the remarkable caves in Wadi Sura, in the western Gilf, where Almásy in 1934 found what is probably the richest series of paintings known in the region.[3] Two large caves here contain paintings; the one cattle and archers, the other chiefly men of a variety of types and drawn in red, white, and, more rarely, yellow. Several distinct styles are represented, and a number of the groups are apparently engaged in social or religious occupations. Perhaps the most intriguing

[1] Winkler, H. A., 'Rock-drawings of southern Upper Egypt, II.' Egypt Exploration Society, London (in preparation).

[2] Shaw, W. B. K., "An expedition to the southern Libyan desert," *Geogr. J.* 87 (1936) 193–221.

[3] Almásy, Count L. E. de, 'Récentes explorations dans le Désert libyque.' Publ. spéc. Soc. géogr. Égypte, Cairo, 1936.

figures are those Almásy [1] styles "nageurs." The attitudes portrayed are certainly strikingly reminiscent of those of swimmers: a strange anomaly in this parched land. Unfortunately the walls and ceilings of these caves have scaled badly, and a large proportion of the paintings have been destroyed. Some have been deliberately defaced, possibly by inhabitants subsequent to the artists who resented or feared the art of their predecessors. It is to be hoped that here, and elsewhere, the remaining paintings will be thoroughly studied and recorded before they are lost for ever, and that the other associated remains on the cave floors will be carefully recorded before students interested only in art have trampled them down.

Later Peel found paintings in a small grotto in the eastern branch of Wadi Abd el Malik, some 12 miles above the junction of the two branches. Cattle only were depicted at this site and were so faint that they had to be moistened before they were clear enough to be photographed.

The Wadi Sura caves lie in the area of more massive sandstones akin to the Karkur Talh rocks, and tentatively identified as Palaeozoic. These rocks weather to give large smooth faces, ideal for painting on. The absence of this type of sandstone along the east of the Gilf may help to account for the lack of paintings in that region. In every case examined the paintings were on the walls or ceilings of caves or abris; the caves were themselves, or were near to, probable water sources; and the floors below often showed implements. At Karkur Talh, Karkur Murr, Wadi Sura, and Wadi Abd el Malik Bagnold found crude but distinctive microliths struck from small quartz pebbles, and at the last two ostrich-shell beads. On the floors of the Wadi Sura caves were also fragments of red ochre, and white and yellow clays which may have been the very pigments used by the artists.

Tibu (Guraan) remains

In Karkur Talh many traces were found of the Guraan who formerly used to visit the wadi. Most of these were probably left by the band of fugitives under Herri who fled here after the French occupation of the Ennedi–Tibesti highlands. Remains of three or four grass huts were found, and a large number of small stone shelters. Several large querns, baskets, ropes, water-skins, and woven mats were scattered round the dwellings, and two parts of camel-saddles were found. Pottery with a distinctive decoration was also present. A collection of these objects was brought back for study and publication elsewhere. A few traces of occupation were seen in Karkur Murr, and a number in Abd el Malik, where pottery was found with a decoration identical with that of the 'Uweinat examples. There was no evidence however that the Tibu had been in the region for a number of years.

Appendix: List of rock-painting sites in the Libyan desert (Egyptian and Anglo-Egyptian Sudan).

Rock-paintings (as distinct from engravings, etc.) have now been found at the following places:

(1) 'Uweinat: Karkur Talh. A large number of sites by Prince Kemal el Din, Hassanein Bey, Almásy, Winkler, and Myers.

[1] Almásy, *op. cit.*

(2) 'Uweinat: Karkur Ibrahim. By Hassanein Bey.
(3) 'Uweinat: Karkur Murr. By Bagnold.
(4) 'Uweinat: 'Ain Dua. By Almásy.
(5) Gebel Kissu. By Almásy.
(6) Yerguehda Hill. By Bagnold.
(7) Gilf: Wadi Sura. By Almásy.
(8) Gilf: Magharat el Kantara. By McEuen and Shaw.
(9) Gilf: Wadi Abd el Malik. By Peel.

4. THE GILF KEBIR. By R. F. Peel

The extensive sandstone plateau of the Gilf Kebir was discovered as recently as 1926 by Prince Kemal el Din during the course of his expedition to Sarra [1]; but he did no more than skirt its south-eastern scarps, fixing upon the map the positions of their major promontories. Bagnold [2] in 1930 followed the Prince's tracks to 'Uweinat, but again did not stop to penetrate the plateau. The western side remained unknown until 1931, when P. A. Clayton, of the Egypt Desert Surveys, accomplished a remarkable feat of high-speed surveying in sketching in the western cliffs as far north as lat. 23° 35′ in a single day's journey from 'Uweinat.[3] In the following year the expedition of Sir Robert Clayton East Clayton and Count L. E. de Almásy advanced north of P. A. Clayton's turning-point in 1931, and spent some time in exploring and mapping the western side of the northern Gilf. During this expedition the wadis of Abd el Malik and Talh, containing live vegetation, were seen from an aeroplane reconnaissance, but attempts to reach them on foot failed.[4] Returning in 1933 with Wing-Commander H. W. G. J. Penderel, Almásy approached the Gilf from the east, and found that instead of being a continuous plateau it was divided into northern and southern sections by a narrow gap which afforded an easy through-route for cars. Passing through this gap (El 'Aqaba) Almásy returned to his attack on the northern wadis and explored extensively in the neighbourhood of Abd el Malik on foot, while Penderel pushed north along the eastern side.[5] Meanwhile however Clayton had been active in the region and had forestalled Almásy by penetrating into Abd el Malik by car, continuing his explorations round the north of the Gilf during 1933 and 1934, and fixing in the main outlines of the plateau in that region. Finally in 1935 W. B. K. Shaw reached the Gilf from the east, and passing through the gap spent some time in exploring the wadis in the extreme south of the plateau before proceeding on his way to El Fasher.[6]

No expedition from Egyptian territory had visited the Gilf since 1935, but new information had been collected about it by Almásy from an old Arab,

[1] Kemal el Din, Hussein, Prince, "L'exploration du Désert de Libye," *Géographie* 1928 (50) 171–183; 320–336.

[2] Bagnold, R. A., "Journeys in the Libyan desert, 1929 and 1930," *Geogr. J.* 78 (1931) 13–39; 524–35.

[3] Clayton, P. A., "The western side of the Gilf Kebir," *Geogr. J.* 81 (1933) 254–9.

[4] Clayton, P. A., *loc. cit.*

[5] Penderel, H. W. G. J., "The Gilf Kebir," *Geogr. J.* 83 (1934) 449–56. Also Berman, R., "Historic problems of the Libyan desert," *Geogr. J.* 83 (1934) 456–70.

[6] Shaw, W. B. K., "An expedition to the southern Libyan desert," *Geogr. J.* 87 (1936) 193–221.

Abd el Malik, after whom the largest of the northern wadis is named. This man, fugitive from Cufra after the Italian occupation of 1931, revealed that until recent times the Cufra Tibu had grazed their camels in the northern wadis after rains, and that he himself had continued this practice after discovering the wadis and capturing the Tibu camels. He also vouched for the existence of a well in Wadi Abd el Malik. A full account of his disclosures has been given by Almásy [1] and summarized by Bagnold in this *Journal*.[2]

As a result of these various expeditions the general nature and extent of the Gilf were known prior to our expedition, and its outlines were shown on the latest (1935) edition of the official 1 : 500,000 map in fair detail. Apart from the work of Clayton and Almásy in the north however little was known about the interior, and the southern plateau in particular remained virtually a blank space on the map, bordered by forbidding lines of hachured cliffs. Our attention was accordingly directed mainly to this area, and in the course of three weeks' work we were able to explore most of its wadis and, eventually, its surface, with results shown in the map accompanying this paper (following p. 376). Later, as Bagnold has related, we also visited the northern Gilf and were again able to add some details to the existing map.

General description

The plateau has a total extension in latitude of more than 150 miles, and a maximum breadth of some 50 miles. Its total area must be in the neighbourhood of 6000–7000 square miles, more than half that of Belgium. As Almásy discovered, it is divided into two parts by an erosional trough in lat. 23° 30′, the southern plateau being much more homogeneous and clearly defined than the northern. Altitude observations are few, but such as exist show that the plateau surface is some 3500 feet above sea-level in the south, and drops to about 1500 feet in the north. The cliffs are also highest in the south, and decline steadily from about 1500 feet at the southern tip to zero in the extreme north, where the plateau merges into the plains underlying the Sand Sea. The surface is remarkably flat, and the dip so slight that to the eye the surface appears uniformly horizontal.

The plateau is dissected round its edges by numerous deep and gorge-like wadis. These have eaten their way back into it for considerable distances, especially in the northern Gilf, which is in parts merely a series of narrow tongues of plateau separating the deep and twisting wadis. Abd el Malik for example, has a total length of approximately 60 miles. The northern plateau is in fact to a large extent screened behind a maze of flat-topped hills, outliers of the plateau detached from it by wadi erosion. The smaller of these have been reduced by denudation to the isolated conical hills so characteristic of the Nubian sandstone country.

Apart from the well reputed to exist in Wadi Abd el Malik, for which we searched in vain, the whole region is absolutely waterless, and vegetation, apart from odd tufts of grass, had been found previously only in the three northern wadis of Abd el Malik, Talh, and Hamra. It seemed possible

[1] Almásy, Count L. E. de, 'Récentes explorations dans le Désert libyque.' This work gives a further account of all Almásy's expeditions.

[2] Bagnold, R. A., "The last of the Zerzura legend," *Geogr. J.* 89 (1937) 265–8.

however that similar live wadis might exist in the southern plateau, a factor which lent an added interest to our exploration.

Exploration and survey

The exploration and mapping of the southern plateau produced problems of some difficulty. It was originally hoped to map the plateau surface by plane-table, working between control points fixed astronomically. This idea proved impracticable on account of the distances involved and the featureless character of most of the surface. The wadis themselves are quite invisible from even a short distance. As these wadis were the most important features to map, it was therefore decided to work from below, and to run a series of traverses up the wadis and round the cliffs, closing on to points already shown on the map with reasonable accuracy. This method allowed us to explore a great deal of ground in a short period, but left the actual surface untouched. Eventually however we succeeded in getting a car up on to the plateau, and ran a zigzag traverse across it, tying in various wadi-heads *en route* as a check on the previous work. As a further check an astronomical fix was taken of a prominent hill on the plateau, and the various traverses were corrected on to this fixed point.

Owing to the long distances to be covered, traverses had to be made by car, with sun-compass and speedometer mileage, in the manner of normal desert navigation.[1] For this small-scale work however some minor defects in the method assumed considerable importance. In following a course over a day's run it is generally found sufficient to change the setting of the sun-compass every half-hour; the errors in the two quarters more or less cancel out. In small-scale work, particularly during the midday hours when the sun's azimuth is changing rapidly, one is seldom on the same course for long enough for this cancelling-out to occur. It was found advisable to change the compass setting every quarter-hour, and over the midday period almost continuously. By doing this errors of bearing were reduced to a negligible quantity, in spite of the rapid twists and turns of the wadis. Errors of distance were more serious. The over-size tyres fitted introduced a negative error throughout the expedition, but unfortunately this error did not remain constant. It appeared to vary with the load, the tyre pressure, the speed, and the nature of the surface traversed. A maximum error of 15 per cent. was recorded when running fast and light to Bir Misaha. Running slowly, and heavily laden, the average was 2–5 per cent., but it proved difficult to estimate the error in any particular instance. By reason of the checks employed however these errors were largely eliminated from the detailed survey. In all some 800 miles were covered in the course of this work. Detail was filled in round the traverse lines by visual sketching and compass intersections. Aneroid readings for altitude were taken at a number of points on the plateau and in the wadis, and the map drawn in the field on the scale of 1 : 250,000. A fair copy was taken off the original field-sheet directly on return to England and sent to the Egyptian Topographical Survey. With their concurrence, descriptive Arabic names have been given to the more

[1] For an account of the sun-compass and its use in desert navigation see Newbold, D., *Geogr. J.* 78 (1931) 526–30. Also 'Hints to travellers,' vol. 1, eleventh edition, pp. 145–9.

important features for easy reference to the places mentioned in this and other papers.

Geology

The Gilf lies in the middle of the broad plain of Nubian rocks forming the central part of the Libyan desert, and is itself essentially a relict plateau cut out of the sandstones and pebble beds of the Nubian Series.[1] The bedding of this series is here apparently horizontal, but the gentle decline of the plateau surface towards the north and east indicates a low angle of dip in that direction. This dip becomes apparent to the eye in the series of east–west escarpments between the Gilf and Kharga.[2] From the surrounding plains the cliffs rise abruptly, giving excellent cliff sections in which individual beds can be traced for great distances. A typical section on the east of the Gilf, taken at the base camp, gave the succession shown in Fig. 1.

This sequence corresponds closely to that given by Sandford[2] for the

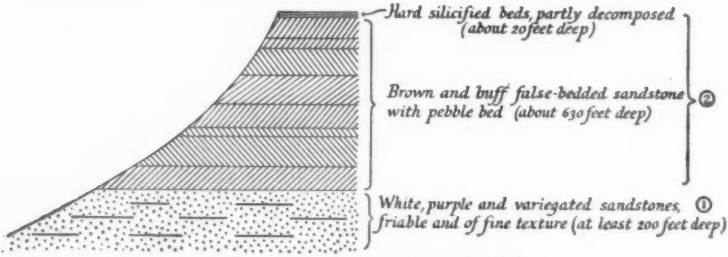

Hard silicified beds, partly decomposed (about 20 feet deep)
Brown and buff false-bedded sandstone with pebble bed (about 630 feet deep)
②
White, purple and variegated sandstones, friable and of fine texture (at least 200 feet deep)
①

Fig. 1. Section of the Gilf cliffs

Nubian Series east of the Gilf, although no basal conglomerate or breccia such as he records was found between 2 and 1. Sandford has put forward the view that the lower part of the succession in the Gilf may be Palaeozoic in age.

Along the western side of the Gilf a similar succession is to be seen, but in the region of Wadi Sura (lat. 23° 35′) and for a short distance north sandstones of a different type outcrop in the lower part of the cliffs. These are of a darker brown, and more massive in structure, than the typical Nubian beds, and are essentially similar in appearance to the massive sandstones round Karkur Talh on the northern flanks of 'Uweinat. They have an apparent dip north-eastwards under the plateau, and may be referable to the earlier Palaeozoic sandstones of Sandford.[3]

Structure: igneous rocks

No signs of disturbance in the horizontal bedding were seen in the outer cliffs of the plateau, although P. A. Clayton had recorded the presence of an

[1] Sandford, K. S., "Geological observations on the north-western frontiers of the Anglo-Egyptian Sudan and the adjoining parts of the Libyan desert," *Quart. J. geol. Soc.* 91 (1935) 342.

[2] Sandford, K. S., *ibid.*, pp. 345–6.

[3] Sandford, K. S., *ibid.*, pp. 334–54.

east–west anticlinal fold in the Abd el Malik region.[1] During the exploration of the wadis however signs of minor folding were noticed in the cliffs of Wadi Ras al Qibli, and immediately afterwards water-worn fragments of a heavy and dark igneous rock were picked up in the wadi bed. Higher up this wadi the source of these fragments was found in two rounded hills of basalt. On climbing on to the plateau surface a number of similar basalt hills became visible, standing out above the level surface in low rounded domes. During the next two weeks the central part of the plateau was traversed, and similar basalt hills were found to extend far to the north, and to link on to the two exposures already known in the extreme north-east. In all nearly fifty exposures were found and mapped, over a distance of about 50 miles. All were of similar type: isolated intrusions akin to volcanic necks, the largest being about $\frac{3}{4}$ mile across. There were no surface traces of connection between them, and no traces of explosive action or of lava-flows. Many lay in a belt of low broken hills running down the centre of the plateau, and the surrounding rocks occasionally showed traces of contact metamorphism. In cases where wadis had cut back close to them the surrounding rocks were seen to be arched up round the intrusion, but no trace of this appeared on the surface. The age of these intrusions must remain doubtful pending detailed geological investigation, but their denuded appearance suggests that the present exposures may be merely the cores of the original structures. The intrusive rocks, all basalts, appear to remain fairly constant in type over the whole area, but details of the petrology will be published elsewhere when the specimens brought back have been analysed.

Craters north-east of 'Uweinat

At this point mention may be made of a second discovery in the realms of igneous geology. As Bagnold has related, on the run south from the Gilf to 'Uweinat our attention was caught by a group of low hills, some 5 miles off our course, which had every appearance of being volcanic craters similar to those found by P. A. Clayton in 1931, 25 miles farther south-west, and later investigated by Sandford.[2] Closer inspection confirmed this view. A row of seven craters rose from the level desert surface extending in line over about 5 miles, the mean bearing of the line being 115–295 mag. (Fig. 2). Camp was pitched at one of the largest of these craters, and in the limited time available notes were made of its outstanding features.

The crater was roughly circular in shape, measuring 1200 yards by 1000 yards (paced internal measurements). The walls consisted of baked and partially fused sandstone, thrust up vertically or even overturned outwards. They reached a height of about 100 feet. Inside the rim was a broad low dome of a heavy greenish igneous rock, in appearance like a diorite. The rim itself was broken by several gaps, and rainwater collecting in the crater had escaped through one of these. A second crater about a mile to the east was smaller, but with steeper and less broken walls. In the centre it contained a compound

[1] Clayton, P. A., *loc. cit.*

[2] Sandford, K. S., *loc. cit.*, pp. 358–66; "Volcanic craters in the Libyan desert," *Nature* 131 (1933) 46; "Extinct volcanoes and associated intrusions in the Libyan desert," *Trans. R. geol. Soc. Cornwall* 16 (1935) 331–58.

neck of basalt, which formed a low dome standing about 50 feet above the level of the plain. Again a stream bed led from the central hollow out through a gap in the rim at one point. The other craters of this group we had to leave unvisited, but from a distant view they appeared to be essentially similar to the two described. The surrounding plains were of rough sandstone with silicified bands, and littered with rock fragments, but in a hurried examination

Fig. 2. Craters north-east of 'Uweinat

nothing was found which could be definitely identified as ejecta, and there were no traces of lava-flows (Fig. 3).

On the following day a second group of craters was discovered some 15 miles to the south-west, intermingled with isolated basalt domes of the Gilf type, and finally similar basalt hills a few miles to the south-east of Sandford's group of craters.

In general characteristics these craters appear to be of very similar type to those described by Sandford, and to form with them a single volcanic field. Igneous activity is indeed manifest over the whole of this area north-east of 'Uweinat, and upstanding walls of prismatic sandstone form a distinctive feature of the desert surface. The craters found, like those of Sandford, look remarkably fresh, but beyond the fact that they are post-Nubian

nothing can be said definitely about their age. Their relationship to the Gilf basalts would be worthy of future investigation.

Geomorphology

Reference has already been made to the outstanding features of the Gilf: the levelness of surface, steep cliffs, and gorge-like wadis. Some additional details may be added which appear of significance in relation to its origin and past history.

The Gilf surface, although sloping gently to the north and east, is remarkable for its altogether unusual degree of flatness and lack of relief save for the

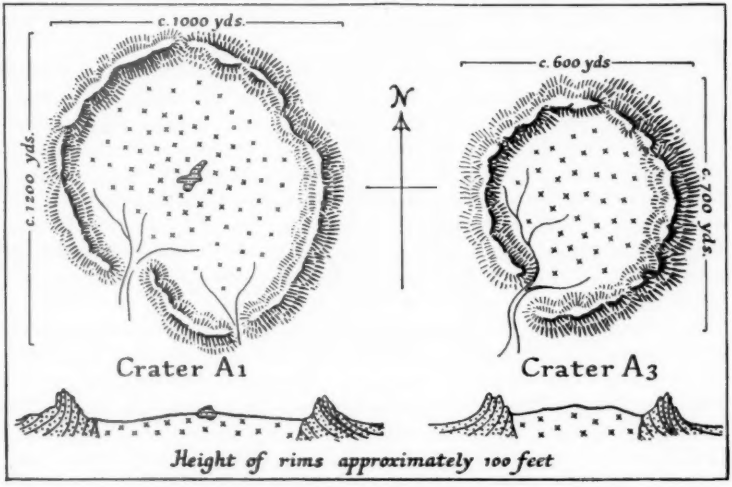


Fig. 3. Plan and section of 'Uweinat craters

basalt hills already noted. No traces of former drainage systems could be distinguished on it. This level surface is apparently continued in the smaller plateaux and flat-topped hills which partially surround the Gilf, those examined revealing an identical structure and rising, so far as could be judged by eye, to just about the same elevation. These features would suggest that the Gilf and its satellites represent surviving fragments of a former land-surface now dissected and largely destroyed by the subaerial denudation which has produced the present desert plains. The present cycle of denudation may have reached comparative maturity in certain areas of the central desert, as for example the Selima sand-sheet, where a level surface has been produced some 1500–2000 feet below the Gilf surface.[1]

The original extension and mode of origin of this last-named surface are matters on which nothing conclusive can be said until there is available much more evidence, both topographical and geological. In recent years the presence

[1] Sandford, K. S., "Geology and geomorphology of the southern Libyan desert," *Geogr. J.* 82 (1933) 211–35.

of extensive dissected peneplains has been recognized in East Africa [1] and South Africa.[2] The Gilf may represent a fragment of a comparable erosion surface of considerable antiquity: but it would be premature in the light of the existing evidence to make any definite claims as to its relationships or mode of origin. Sandford has suggested that it may be correlated with the Jef Jef plateau and many other elevated regions of Nubian sandstone between Tibesti and the Nile. He also suggests that "the southern Libyan desert is in fact a hole gouged out of a very old land surface, made of Mesozoic strata . . . probably reduced to subdued relief in early Tertiary times." [3] In another paper he summarizes this view: "The disposition of high and low ground has led me to suggest (1933) that at least two cycles of subaerial denudation may be recognized, but whether these may be coupled with East African peneplains is not clear." [4]

So far as the Gilf itself is concerned there is little manifest evidence of the actual mode of formation of the surface. It may be a peneplain of subaerial origin, as here inferred by Sandford, but the extreme flatness and lack of relief almost suggest a plain of marine erosion. The present termination of the marine Cretaceous is only some 150 miles to the north, and in a recent letter Sandford has stressed the possibility of marine denudation in Cretaceous or early Tertiary times being the essential factor in the problem. Nothing more than the statement of these various possibilities can be attempted at the present stage, but the problem would repay the attention of geomorphologists in the future.

The surface of the Gilf, although in a sense structurally controlled, since the bedding is nearly horizontal, is certainly one of denudation, the folding round the igneous intrusions having no effect on its flatness. The basalt hills also evidently owe their present shapes to denudation. No reliable estimate of the thickness of Nubian strata missing from the Gilf surface can be made in view of the great distances involved and the very slight and variable angle of dip. A very rough calculation, assuming a constant dip for the Cretaceous from its outcrop to the north, would indicate a thickness to be measured in hundreds, rather than thousands of feet; a conclusion which would conform with Sandford's estimates of the thickness of the series as a whole.[5]

At present thick silicified beds form the surface over wide areas, and by their resistance to mechanical weathering form a protective capping to the plateau. These beds break up into spheroidal masses, which in turn exfoliate with expansion and contraction under the extreme temperature changes into splintered blocks and curved chips, giving a surface anything but pleasant to drive a car over. Over considerable areas however softer sandstones remain above the silicified beds, yielding a smooth surface of small rounded fragments of blackened sandstone. In a few areas the silicified beds have been cut through

[1] Wayland, E. J., "The peneplains of East Africa," *Geogr. J.* 82 (1933) 95; 83 (1934) 79. Willis, Bailey, "The peneplains of East Africa," *Geogr. J.* 82 (1933) 383–4.

[2] Maufe, H. B., *S. Afr. geogr. J.*, vol. 18, 1935.

[3] Sandford, K. S., *Geogr. J.* 82 (1933) 218.

[4] Sandford, K. S., *Quart. J. geol. Soc.* 91 (Sept. 1935) 326.

[5] Sandford, K. S., *ibid.*, pp. 352–4.

(or were locally undeveloped) and the softer underlying sandstones have been dissected into a mass of conical hills; but there is no system about the topography in those areas. Elsewhere the surface shows little trace of recent erosion. In places it is scored with shallow and superficial gullies, some of which lead into shallow closed depressions, but few into wadi-heads. Sand accumulations are completely lacking on the surface of the southern plateau (in the north a few of the great seif-dunes running down from the Sand Sea transgress on to the surface), although the presence of south-pointing sand-drifts in many of the wadis shows that a certain amount of sand does move over the plateau. Implements picked up on the plateau however show little of the sand polish typical of those found on the plains, and from the general circumstances it is unlikely that wind and sand-blast are effective agents of denudation. The greater part of the surface would appear to be undergoing effective attack only from very slow atmospheric weathering and lateral undercutting by retreat of the cliffs and headward recession of the wadis.

The wadis show several features of interest. In plan they follow an irregular radial pattern, the majority draining eastwards. The divide, if such a term may be used of a flat-topped plateau, lies near to the western cliffs, which are little dissected save in the extreme south, where, as Shaw [1] discovered, a few major wadis have cut back right through the plateau. Each wadi runs in a chain of straight lines, connected by abrupt bends; the smooth curves of a normal river valley are conspicuously absent. Tributaries join them at all angles. In cross-section they are typically flat-floored, the surface rising only gently to the base of the cliff walls, except where sand-drifts have accumulated. The cliff walls are invariably steep, showing an average slope of about 33 degrees. They become steeper towards the top, culminating in a vertical, or nearly vertical, lip where the silicified beds crop out. Their lower slopes are clothed in screes, but where not obscured the slopes clearly reflect the varying resistance of the different beds of the Nubian Series by rising in a series of steps. The protective effect of the capping of silicified beds is clearly reflected in the steepness of these cliffs, which appear to retreat by the undercutting of this layer.

It was hoped to make a series of detailed longitudinal and transverse profiles of typical wadis, but this proved impracticable. From the rather inadequate data of aneroid readings taken at intervals up two wadi beds, it has proved impossible to draw accurate profiles; the personal impression gained in passing up them is that the very gentle gradient does not steepen progressively and smoothly as in a normal river valley, but shows a sequence of steeper and flatter sections, being often steeper near the mouth than higher up. The wadis terminate in very steep and narrow gullies, or sheer cliffs, with a very pronounced break of slope at their base.

The mode of formation of these wadis presents an interesting problem. There can be no doubt that they are primarily the product of water erosion. The slope of their beds and concordance in level of their tributaries prove this, and additional evidence is afforded by the presence of very obvious stream beds in them. Viewed from above, the flat wadi floors are seen to be

[1] Shaw, W. B. K., *Geogr. J.* 87 (1936) 193–221.

scored with a multitude of drainage channels, deeply incised into the mantle of water-worn boulders and stones, sand, and mud which hides the solid rock. The latest stream channels have often cut meander terraces fringed with cliffs 6 or 8 feet high in the detritus laid down by their predecessors. The bulk of this erosion probably relates to an earlier period of much more frequent and copious rainfall, a conclusion supported by the fact that artefacts of neolithic age are occasionally to be found in the upper wadis apparently *in situ*; but many of the meander scars look very fresh and recent, and implements picked up in many cases show clear evidence of having been transported. Data on the rainfall of this area during historic times is of course scanty, but from the accounts of travellers who have visited it, and the native reports, heavy rainstorms are liable to occur about every seven to ten years. De Mascarel, a member of Kemal el Din's 1925–26 expedition, writes: "Ouenat n'est pas d'ailleurs complètement privé de précipitations atmosphériques intenses, ni même d'inondations, témoins les arbres flottés que nous avons trouvés dans les ravines de la plaine, à plusieurs kilometres au sud de la montagne, mais ces orages violents sont bien rares."

Kemal el Din himself, after quoting this statement, writes: "J'ai appris récemment que les pluies de l'automne 1927 . . . qui succédaient ici à une période de sécheresse de six années, ont été si abondantes que le bassin de réception dont il est question ci-dessus (contre les dunes, à 25 km. à l'ouest d'Ouenat) a été complétement inondé et que, des sayals qui le parsèment, il n'émergeait que la tête, ce qui suppose une profondeur d'eau dépassant par endroits 2 mètres." [1]

Sandford, in a paper summarizing the evidence of recent precipitation in the area, notes that there was good grass at 'Uweinat in 1923 when Hassanein Bey visited it, and heavy rainstorms occurred in the spring of 1934.[2]

Such heavy rainstorms would give an enormous concentration of water flowing down the wadis, and probably give rise to a mass transport of rock waste, sand, and mud akin to the sheet-flooding of American geologists.[3] Some such mechanism must be invoked to explain the accumulation of detrital material laid down round the mouths of even quite short and insignificant wadis. On reaching the plain the water would rapidly sink away and evaporate as it spread out over a wider area. While it appears clear that water erosion has been the main factor at work in the evolution of the wadis, the exact mode of that evolution is not so clear. The wadis present several curious features: their floors are flat; in many cases their width is out of all proportion to their length, and they grade into open bays; many contain alternating narrow gorge-like sections and broad, open basins; they run at peculiar angles, with tributary wadis occasionally pointing upstream; both in transverse profile and at their heads, the wadi beds end in abrupt cliffs; and there is little or no evidence of water flowing over the plateau surface to pour into the wadis. Most of these peculiarities may be summed up by saying that

[1] Kemal el Din, Prince, *op. cit.*, p. 328.

[2] Sandford, K. S., "Observations on the distribution of freshwater mollusca in the southern Libyan desert," *Quart. J. geol. Soc.* 92 (1936) 201–20.

[3] McGee, J. W., "Sheet-flood erosion," *Bull. geol. Soc. Amer.* 8 (1897); Blackwelder, E., *Bull. geol. Soc. Amer.* 39 (1928).

in the evolution of the wadis, lateral cutting seems to have been as important as vertical. Shaw's phrase puts the matter graphically: "It is as though an army of gigantic maggots, advancing from the east, had eaten their way into the plateau as into a flat cheese . . ." [1]

The problem of lateral cutting under arid conditions, especially with regard to the formation of desert plains, is one that has received much attention from American physiographers. J. L. Rich in a recent paper [2] has summarized the various views put forward, and advanced a theory to explain the retreat of scarps and the formation of rock plains in advance of them. He does not deal with the valleys cut in the scarps, so that his thesis is not strictly applicable to the matter in hand, although it would presumably cover the lateral retreat of the Gilf cliffs, which is in effect part of the same problem. His paper is useful however in summarizing the various erosion processes which are supposed to bring about lateral planation. Briefly these may be stated as: weathering of scarps and removal of the debris by occasional rain wash and wind deflation; lateral water erosion by sheet-floods; and lateral water erosion by heavily loaded streams, swinging widely in the lateral plain. Rich, while favouring the second of these agencies as the most effective, is willing to allow that all three might act together and their relative importance vary with local circumstances. In the Gilf all three may reasonably be invoked to explain the wadis. Wide lateral swinging by fully loaded streams after rainstorms might gradually carve out broad flat-bottomed valleys; while if Tibu accounts of the nature of the rainfall are even partially credited, some form of sheet-wash can readily be imagined covering the whole floor of even a broad wadi, and undercutting its sides. Several of the peculiarities enumerated however cannot be satisfactorily explained even by admitting all these processes. The essence of the problem seems to be to discover some agency which might gnaw away the cliffs from below in rather an irregular manner. In this connection a suggestion made to me by Bagnold seems worthy of consideration. At many points round the base of the cliffs partly obliterated cavities may be noticed. Almásy had no hesitation in identifying some of these in the Wadi Sura as intermittent springs. If rainfall on the plateau surface were to sink straight into the porous sandstones, and reappear near the base of the cliffs as copious springs, irregular undercutting and retreat of the cliffs would undoubtedly follow. This would help to explain the lack of drainage channels scoring the lips of the wadi cliffs and the plateau surface, the irregularity in the outline of the wadis, and the fact that they begin from abrupt cliffs. If this mechanism were allowed, recession of the cliffs and extension of the wadis would take place essentially by sapping and undercutting of the cliffs, the scree material produced being removed *en masse* by sheet-flooding after rains, and possibly by slow wind deflation in dry seasons.

As there had apparently been no rain at the Gilf for a very long period, it was naturally difficult to evolve any means of testing this hypothesis, which must remain purely tentative. Photographs taken from some 300 feet above a typical wadi floor strongly suggest however that, at the last major rains,

[1] Shaw, W. K. B., *op. cit.*, p. 195.

[2] Rich, J. L., "The origin and evolution of rock-fans and pediments," *Bull. geol. Soc. Amer.* 46 (1935) 999–1024.

water had seeped out from the base of the screes to form myriads of small meandering channels on the wadi floor.

A final feature of interest was noted in the wadis. In the upper parts of two of them thick deposits of mud, evidently the beds of ancient lakes, were found. In both cases these lay behind sand-drifts which had grown outwards so as to block the wadi. In the first (Wadi el Bakht), the old lake floor consisted of alternating thin sheets of mud and partly cemented sand with an upper capping of mud some 6 inches thick. Similar reddened and hard sand was found in many of the meander terraces in the wadi beds; probably iron oxides derived from the sandstones and basalts and washed into these sands during their transport are responsible for the alternations. In the lake floor in question little erosion was to be seen, but the sand-drift had evidently retreated, and a small mud cliff was outcropping from the sand face. A section along the wadi floor, kindly taken for me by Myers, gave the profile shown in Fig. 4.

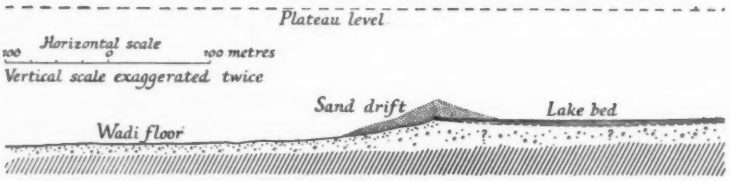


Fig. 4. Section of a wadi

From the evidence of the profile, and the entire absence of any other barrier, it appeared that the lake must have been held up by the sand alone, while vigorous erosion lowered the wadi bed below the obstruction. The lake bed, sand-drift, and to a lesser extent the wadi floor below were literally covered with stone artefacts, and Myers spent three days in working the site, with profitable results.

The second lake bed was found at the head of Wadi Ard el Akhdar, farther south. The wadi presented many surprises; Shaw had explored the main wadi, but had not entered this narrow branch, which indeed gave every indication of petering out almost immediately. Instead of doing so however it continued as a narrow gorge for some 20 kilometres into the heart of the plateau, and terminated in a remarkable amphitheatre surrounded by rounded basalt hills. The wadi, at the point where it left this amphitheatre, was nearly blocked by a sand-drift similar to that in El Bakht, and in the basin beyond eroded mud deposits again indicated the former presence of a considerable lake or marsh. In this example the lake floor had been deeply eroded, probably by the cutting through of the sand barrier, and now formed isolated vertical-sided blocks of mud, rising 10 feet or so above the present surface. The floor of the depression again proved to be rich in archaeological sites, which were later worked in detail by Myers.

To sum up, it may be said that in the evolution of the Gilf erosion by running water appears to have played by far the most important rôle in shaping the topography. The general process seems to have been a steady retreat of the cliffs, both round the edges and in the wadis, with mass removal of detritus and perhaps lateral planing by sheet-wash. Erosion by wind and

sand has probably played but little part in the dissection of the plateau and the shaping of the wadis, though these have most likely been the main agents at work in the final scouring down of the plains, and perhaps in the degradation of isolated fragments of the plateau into conical hills and the elimination of the mounds of debris which form their penultimate stage.

Wind scour may also be the main factor responsible for one final and rather puzzling feature of the Gilf topography. In similar topography in Arizona, which furnishes most of the evidence used by Rich and other American writers in their theoretical discussions of desert planation, the desert scarps appear to be normally fringed by rock-fans or pediments, sloping gently upward from the plains to the foot of the scarps proper. There are no signs of such rock-fans, as distinct from detrital accumulations, round the Gilf cliffs: indeed, in many localities there is a perceptible descent towards the cliffs from the plain, and the mass of 'Uweinat appears to stand in a definite depression, as viewed from its eastern side. If these cliff-base hollows really exist, they must owe their origin to differential erosion, and several possible modes of formation may be suggested. On the one hand they may have been cut by water erosion of the streams issuing from the wadis and abrading the desert surface immediately below the cliffs before evaporating and sinking away. Certainly one would expect the action in the immediate zone of the cliffs to have been constructional, but wind may have carried away the detritus in between rains, and in the long run the combination of stream erosion and removal of the waste by wind may have led to a more rapid lowering of the surface here than out in the open plains. On the other hand wind action alone may have been responsible. Topographic factors may have concentrated wind scour along the base of the cliffs, and the resultant erosion may have been assisted by the growth of vegetation round the highlands, the roots breaking up the surface and facilitating the removal of fine particles by wind in the manner suggested by Ball as possibly contributory to the growth of the oases depressions.[1] Speculation on this subject is perhaps premature before the visual impression that such hollows exist has been confirmed by accurate measurement; but it is difficult to refrain from it in the face of the many unsolved problems of this strange land.

5. ROCK-PICTURES AT 'UWEINAT. By Dr. H. A Winkler

The late Sir Robert Mond had generously enabled me to explore during the seasons of 1936–37 and 1937–38 the Upper Egyptian deserts east and west of the Nile. The aim of this exploration was the collection of rock-pictures, which are found near the wells, or in those wadis which attracted animals and men by their vegetation, and along the old migration and trade roads. The season of 1937–38 was devoted to the exploration of the western desert, the edge of the desert touching the Nile valley from Qena to Aswan, the roads from the Nile valley to the oasis depression, the oasis area (mainly the Gubari road between Kharga and Dakhla), and 'Uweinat. To explore 'Uweinat, famous for its rock-paintings, I joined the expedition of Major R. A. Bagnold and Mr. O. H. Myers during the last month of the season. On March 10 I

[1] Ball, J., "Problems of the Libyan desert," *Geogr. J.* 70 (1927) 34.

left Kharga with Myers and his party. I had done all my former explorations on camel-back or on foot. I had admired and loved the strength, patience, and steadiness of my camels. Now I bade them farewell, and enjoyed the power and the speed of cars running over the huge sheets of barren sand which my camels would have so disliked.

The rock-drawings of the Upper Egyptian deserts date from neolithic times to the present day. For the last five millennia the rock-drawings can here be connected with Arab, Coptic, Greek, or ancient Egyptian inscriptions and thereby dated. Within this period (in Roman times) the camel appears in the pictures. The earlier drawings are divided into two main groups: a period in which the artists knew and depicted cattle, and a pre-cattle period. Within these two periods five different peoples made rock-pictures, distinguished by their dress, weapons, crafts, style, and habitat. The most recent of these predynastic groups is characterized by a type of papyrus boat frequently represented in their rock-pictures; they are the Early Nile-valley Dwellers, contemporary for the most part with the second Nagada (Gerzean) civilization. They are later than, and influenced by, a people who came across the Red Sea from somewhere in the east in straight wooden boats, probably dug-outs, with high vertical prows and sterns. These are the Eastern Invaders. Both peoples had to deal in the mountains with a race of cattle-breeders, wearing the Libyan sheath, probably the forefathers of those peoples who appear in historic times as speaking Hamitic languages. They are superior in this art to all the others. I have called them the Autochthonous Mountain Dwellers. They are found from the Red Sea hills to 'Uweinat and even farther west. In the oasis area near Dakhla another people has left us its rock-drawings, clever stone-workers, settled people, plant-cultivators, probably adoring a pregnant goddess. Pictures of pregnant women are characteristic in their rock-artistry. These are the Early Oasis Dwellers. They lived in connection with an archaic hunting people, who never depicted cattle and certainly did not know cattle in the earlier part of their long existence in these regions.[1]

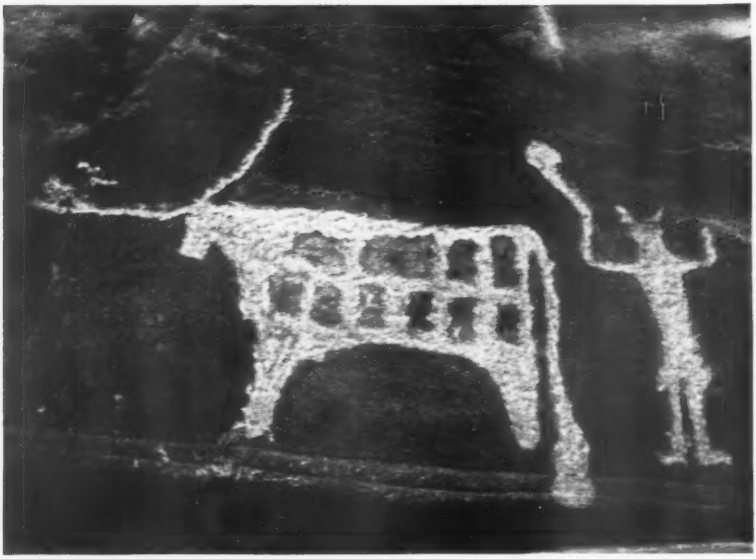
At 'Uweinat an unusual number of rock-pictures proves first of all the importance of this pasture oasis. There are a few engravings of camels and human beings which by their lack of patination show that they are recent work. In all probability they have been made by the Tibu who still visit 'Uweinat, and whose huts, leather pots, and other remains we found. All the other engravings have a patina. There must be a considerable lapse of time between the modern engravings characterized by the camel, and the earlier ones characterized by cattle and giraffes. The absence of intermediate drawings suggests to me that these valleys had been abandoned at an early date by the people who made the cattle and giraffe drawings, that for many centuries nobody came here, and that finally only the camel enabled and induced men to visit and to rediscover these valleys.

The earlier pictures are engravings and paintings. In both, cattle are the main subject. The engravings appear in many degrees of patination, and the paintings in many shades from the faded and hardly visible to those in excellent preservation. Superimpositions occur amongst the engravings as well as

[1] See the author's reports, 'Rock-drawings of southern Upper Egypt, I and II.' London, Egypt Exploration Society, 1938–39 (vol. II in preparation).

'Uweinat (Site 72): men dancing, women in skirts

'Uweinat (Site 75): mottled cow with the udder between its hindlegs



'Uweinat (Site 73): mottled animal, man with club

'Uweinat (Site 74): unknown animal, man with hairdress and feather

amongst the paintings. But there are no indications that distinct peoples lived here. Engravings and paintings seem all to be the records of one single people who lived here throughout a very long period.

These peoples were cattle-breeders. They are the same people who are found also in the deserts closer to the Nile valley and are there intermingled and interconnected with other predynastic peoples. The examination of the rock-drawings of these Autochthonous Mountain Dwellers in the eastern desert leads to the suggestion that they are some sort of early Hamites. Everywhere they appear connected with cattle. They knew the giraffe in 'Uweinat, as even their latest pictures prove. In the eastern desert they knew also the elephant. Cattle were hunted by them in the eastern desert; in 'Uweinat it seems only to be domesticated. Mottling—a result of domestication—is represented with much care. Necklaces, amulets, and horn ornaments indicate the love of and possibly the cult significance of cattle. Large and full udders show that the breeder appreciated the milk. The usual position of the udder between the hindlegs tells us that the people used to milk their cows from behind. Twice huts are depicted, and pots hang down from the roof. They are painted white inside, certainly to represent milk.

Hunting was less important. These people had, and represented here and elsewhere, a kind of greyhound. Barbary sheep, ostriches, and giraffes were caught in traps. Ostriches were tamed: one drawing shows a child playing with an ostrich. Straight and bent sticks with or without knobs were the main weapon, but bows and arrows also occur. Shields are frequent.

Men are depicted with large strips over the genital parts, probably the Libyan sheath. Strings at the chest and waist, fringes below the knees, sandals, bracelets, armlets, and anklets show current fashions in men's dress. On several occasions their legs are spotted, probably representing paint. Several human beings wear animals' hides. Women are simply dressed; several times they are shown wearing short skirts.

The dating of the Autochthonous Mountain Dwellers is obtained by their relations to predynastic rock-drawings in the desert nearer to the Nile valley, but they cover a long period. They appear in early predynastic times, well before 3200 B.C., and continue until late into dynastic times.

In comparison with rock-pictures of the other groups those of the Autochthonous Mountain Dwellers are distinguished by their fine art. They possessed a definite style, which I have called the style of balanced exaggeration. It is based on an exact observation of the proportions and curves of the human body. The shoulders are drawn broader and more raised and the waists thinner than in nature; the buttocks are accentuated, sometimes contrasting effectively with the thin waists. The legs are often heavier and longer than in nature. This style is found everywhere among Autochthonous Mountain Dwellers, and at 'Uweinat and in the western Gilf we possess one of the richest provinces of their art. It is interesting to see how this very distinct style occurs all around the habitat of these early pastoral people. It is found in the rock-paintings of eastern Spain, in Minoan Crete, on the Greek geometric art, and traces of it in early dynastic Egypt. We find it in recently discovered rock-paintings in eastern Africa and again in the south of the continent in the Bushman art. Further research will establish how far peoples

themselves migrated carrying with them their art, or how far only the style had been handed from nation to nation as a convincing conception of human beauty. It is noticeable that at the borders of the distribution of this style the Egyptian as well as the Cretan art arose. It may be audacious to connect the early eastern Spanish paintings (I prefer the opinion that they are of neolithic age) with these Saharan pictures, and these with early dynastic monuments, with Minoan Crete, and with the geometric style of Greece; and to extend this connecting line to some as yet undated East African paintings, and to the pictures of the Bushmen, which are to a large extent certainly not more than a few centuries old. Nevertheless the style is unique and so definite that we must consider such connecting lines, distant though they may seem. From this point of view the rock-pictures of 'Uweinat become important. They may illuminate not only some local problems of a certain early period but problems comprising the whole continent of Africa and of southern Europe, and covering the millennia from neolithic until present times.

There is still much to be done. 'Uweinat still holds many paintings which no eye has seen since the last of the ancient cattle-breeders left. Major Bagnold and Mr. Peel visited the rock-painting sites in the western Gilf and discovered new ones. The pictures there are identical in subject and style with those of 'Uweinat. They confirm and enlarge our knowledge of the ethnology of these cattle-breeders and provide splendid examples of their art. Pottery and implements also shed some light on the problems. One day it will be possible to establish clear relations between pictures on the rocks and the remains on and underneath the ground. We shall then know more about the periods within the long history of these cattle-breeders in the Sahara and about the trends of their migrations. And we shall then probably know how far the tribes themselves travelled, and how far their style spread.

6. SAND MOVEMENT AND DUNES. By R. A. Bagnold

My main object being to confirm my experiments made in a small wind-tunnel in which wind speeds could only be measured up to a height of 6 inches above the surface, I hoped for as many good sandstorms as possible during which to repeat the measurements in the open. Both the area and the time of year were chosen with that in view. As it turned out, that spring was a very abnormal one both in the southern desert and in the Mediterranean. I was only able to make observations during two real but not very violent storms. Neither occasion was at all enjoyable. The wind was bitterly cold, and the effort of setting up and adjusting a delicate liquid gauge to measure the wind speeds at ten different places at the same time in a stabbing sand-blast, not to mention taking continuous readings with it for an hour or so, is not one to be repeated with overmuch enthusiasm. For all that, the results obtained were highly satisfactory; the connection between the quantity of sand in movement over a dune surface and the velocity of the wind, given in the *Journal* for May 1937 as the result of small-scale experiments in London, appear to be confirmed in the open desert in a remarkable way.

Experiments were carried out on the granular structure of "liquid" sand and of firm wind-bedded sand, and interesting results were obtained which

point to a simple connection between the sand structure (mode of deposition) and its ability to absorb and to hold moisture; this in turn was corroborated by a comparative examination of the structure of dune sand, in which grasses had succeeded in taking root, and of sand nearby which was barren.

Observations were also made on the size-grading of the grains on the surfaces of dunes which were seen to be growing, and of those which were seen to be falling, in confirmation of the results obtained experimentally in London and published in *Proceedings* of the Royal Society, November 1937. Finally, by observation in the rare areas where both seif and barchan dunes exist in close proximity, it has been possible to obtain several lines of evidence pointing to the conditions determining which type will develop in a given spot.

Some details of the above results have already been published (*Proceedings* of the Royal Society A.167, pp. 282–92, August 1938, and in *Nature* 142 (1938) 403). It is hoped to embody other results and conclusions in book form shortly.

7. TRANSPORT, NAVIGATION, SUPPLIES. By R. A. Bagnold

The cars used were 30-h.p. Ford V8, 1937 models. Two of them had the standard American factory-built pressed-steel "pickup" body, and the third (mine) had an open light wood body which was specially built in Cairo. The front and rear springs of all the cars were strengthened by the addition of extra leaves, and the cars were fitted with the big 13×900 "airwheels."

They carried about 1 ton each when fully loaded, which they were on many occasions and for long distances. The mileage done per car during the expedition was about 5000. Petrol consumption across country, not following any previously beaten track whatever, was 10 miles per gallon (150 kilometres per case of 8 gallons was a useful figure for reckoning). The oil consumption was negligible. The water began to boil on one or two occasions on hot days with a following wind, but this was in no way serious.

Our only mechanical breakdowns consisted of the breaking of three rear axles (those on both Myers's cars also broke during the return journey from Kharga) and two cardon shafts after reaching the Nile valley. The springs held up astonishingly, considering the overloading and the rough country the cars were taken over. The ignition timing mechanism did however require much adjustment, and needed considerable experience, which was fortunately possessed by our mechanic, in diagnosing its ills. Otherwise the chassis gave no trouble.

The failure of the transmission was our own fault, due to overloading the cars. My previous experience with former models of Fords had been that the chassis could be overloaded to any extent if one did not mind risking the fracture of external and easily repairable parts such as springs and chassis frames. But the chassis of the V8 has now been made so strong that the elements of rebellion have, so to speak, been driven underground. The failure was due to the combination of a very powerful engine, overloading, and exceedingly bad going over boulders. I imagine that over the same country and with the same overloading no trouble would have occurred if the engines had been exchanged for ones of lower horsepower. Alternatively 1-ton lorries, with the big engines retained, might be suitable.

The factory-built bodies however gave rise to a serious difficulty. The driving-cab is totally enclosed and is of pressed steel. A magnetic compass is almost useless inside it, being completely screened from the earth's field of influence. Neither can a sun-compass be fitted in any position accessible both to the sun and to the eye. We had therefore to rely for navigation on my open wood-bodied car. As this was the one which was abandoned, we had to fit the sun-compass to the back of one of the other cars for the return journey. The result was that the navigator, who had to sit behind near the compass, was perched up on top of the freight and unable to read off the speedometer the distance run. This was overcome to some extent by the driver signalling with his horn the appearance of every tenth kilometre on the speedometer.

The carrying capacity of the cars and the range of action of a small party equipped with them can be judged from the following. On the return run after drawing supplies from Selima each car carried 140 gallons of petrol, enough for 1400 miles; 36 gallons of water, enough, at 4 pints per head, for two people for thirty-six days; 400 lb. of food, enough for two people for sixty days. Allowing some reduction of this load for the carriage of camp equipment, etc., it is quite feasible for a party of six or eight in three cars to visit this fascinating area and to stay there for a whole season entirely independent of all supplies including water, save for monthly trips with two cars to Dakhla or Kharga.

Water was stored in bulk in new 4-gallon petrol tins, packed in pairs in light wood boxes, in just the same way as petrol is carried on all desert expeditions in Egypt. These tins were soldered up. Two-gallon petrol tins were also used, as on former expeditions. Both types of container began to rust slightly inside after a few weeks, but this was not serious. At the end of the first month we emptied all the tins and rinsed them out with paraffin wax of high melting-point which had been brought almost to the boil. The thin film of wax over the inner surface of the tins completely prevented further rusting, and, except in one unaccountable case, did not in any way flavour the water. This scheme is strongly to be recommended, though an investigation is needed to ascertain why a nauseating waxy taste appeared in the one case.

It may be of interest to record that we examined a dump of water left at an isolated hill—in permanent shade—near the Italian border west of the Gilf by Almásy in 1933. The water was soldered up in 4-gallon tins (unwaxed). We took one of the tins, replacing it by one of our new ones, and lived on the 1933 vintage for several days without any ill effects. The initial red rust inside had turned in course of time to a black sludge, but as this had settled on the bottom we were able to syphon off the clear water above. It was tasteless and perfectly good.

DISCUSSION

The PRESIDENT (Field-Marshal Sir PHILIP CHETWODE) said: I wish, before calling upon Major Bagnold, to say to you what I said to the Council this afternoon. Several months ago you did me the honour of asking me to become your President. Almost the day afterwards the Government asked me to go to Spain to do my best with the Commission to effect the release of some of the prisoners from both sides in that terrible conflict. I could not

possibly refuse and so, having asked your Council to let me go, I am afraid I have been rather a broken reed. Although the Commission has not been able to reduce the number of prisoners to any great extent, it has undoubtedly been the means of saving many hundreds of lives. You will not feel therefore that I have deserted you for an unworthy cause.

Major Bagnold requires no introduction to you. He received the Founder's Medal in 1935 for his journey to the Libyan desert, and last spring he made another remarkable journey to the plateau of the Gilf Kebir and 'Uweinat, in company this time with Mr. Oliver Myers, of the Egypt Exploration Society, Mr. R. F. Peel, and Dr. Winkler, whom I will also ask to address you.

Major Bagnold, Mr. O. H. Myers, Mr. R. F. Peel, and Dr. H. A. Winkler then read the papers printed above, and a discussion followed.

Dr. K. S. SANDFORD: I want to congratulate Major Bagnold on another successful expedition, and on the abundant results obtained from remaining for some time in the Gilf Kebir and round 'Uweinat. Mr. Peel has explained that the steep-sided cliffs and valleys of the Gilf might owe their shape to the undercutting action of springs near the level of the surrounding plains: this suggestion receives some support from the occurrence of such springs at the foot of similar cliffs in some of the arid territories of North America. The presence of caves at the foot of the cliffs in the Gilf also suggests some such action. It is evident that the rainfall in the Gilf has been sufficient to enable people to frequent the area, but in deserts, as elsewhere, high land normally receives more rain than the surrounding plains. The sandstone hills south of 'Uweinat probably enjoy now the type of rainfall that from time to time the Gilf had received. These and other considerations suggest to me that the people described by Mr. Myers ebbed and flowed from south to north, from Darfur and Kordofan, and perhaps we need not look so far as the western Sahara for them. Further, the querns of which we have seen photographs are carefully finished and smoothed on their lower sides and their weight thus reduced to a minimum: presumably this reduction was intended to make them easy to carry. We need not therefore assume that the people remained in the area, though they may have done so. The evidence yet available can be explained by seasonal or sporadic migrations in times of good grazing, and it seems to me that the pottery was brought into the area in similar circumstances; the same movements go on to-day not very far south of 'Uweinat, and even this mountain had a considerable population a few years ago. Dr. Winkler has shown us some remarkable rock-pictures, and his evidence of superposition of styles is very striking and of the greatest importance to the history of this fascinating region.

The PRESIDENT: I think you will all agree with me that the four lecturers have put before us matters of very great interest. Some of you may know a good deal about these matters already, but I am sure that to others sand is sand, and rocky country is rocky country and not much more. From the experience I have had of that part of the world, sand conveyed nothing very much to me. Indeed, it produced on my mind and on the minds of those with me a feeling of the most profound gloom. The lecturers however have made the sand and rocks speak to us. To think that people breathed and moved and had their being on that desert plateau, and milked cows and shot ostriches and dug caves, is a moving thought and most interesting.

Without more ado, I ask you to convey our most sincere and profound thanks to the lecturers for providing one of the most interesting evenings that I can remember.

DISCUSSION ON THE FINAL REPORT OF THE DEPARTMENTAL COMMITTEE ON THE ORDNANCE SURVEY

Afternoon Meeting of the Society, 16 January 1939

THE CHAIRMAN (Sir CHARLES ARDEN-CLOSE), in opening the meeting, said: This afternoon we are to discuss the Final Report of the Departmental Committee which was appointed to consider various matters connected with the Ordnance Survey. Brigadier MacLeod has kindly agreed to open the discussion, and we look forward to hearing an authoritative account of the decisions that the Committee has come to. I may say at once that the Report is an exceedingly valuable and important document with which I hope most of us will agree.

Brigadier M. N. MACLEOD: I would like to start to-day by saying how much I regret Lord Davidson's absence. The Final Report of his Committee amounts to a new charter for the Ordnance Survey; it is an important State document about which he could speak with an authority that cannot attach to any words of mine. I can summarize the Report, and perhaps amplify explanations given therein, but I cannot give, as Lord Davidson might have done, impressions made on the Committee by the evidence they heard, or comment on items which the Report leaves unsaid. I might perhaps explain at the outset that I was not a member of the Committee. I attended its meetings in the capacity of expert adviser. Besides the chairman, the Committee was composed of representatives of the Treasury, the Ministry of Health, the War Office, the Air Ministry, the Scottish Office, and the Ministry of Agriculture and Fisheries. The reason for its composition was, I imagine, that in the first instance the problem for which the Committee had to find a solution was how to provide up-to-date maps for the use of local authorities, to enable them to carry out the terms of the Town and Country Planning Act. This was mainly a matter for the Ministry of Health, the Scottish Office, the Ministry of Agriculture and Fisheries, and the Treasury. As however any special arrangements for the benefit of one particular ministry, or for one particular purpose, cannot be isolated from the general programme of the Ordnance Survey, representatives from the War Office and the Air Ministry, as the two departments most interested, were added.

The terms of reference of the Committee were:

> To consider what measures are necessary to accelerate the revision of the Ordnance Survey maps in order to bring them up to date and thereafter to maintain them at a high level of accuracy, while providing for such other public services as are undertaken by the Ordnance Survey Department;
>
> To consider what immediate steps are possible in the meantime to revise Ordnance Survey maps to the extent necessary for the purpose of town and country planning schemes;
>
> To review the scales and styles of Ordnance Survey maps placed on sale to the public and to recommend whether any changes are desirable;
>
> To review the conditions upon which the reproduction of Ordnance Survey maps is permitted.

The second and fourth items required immediate action and were disposed

of in an Interim Report published in December 1935. The Committee thereupon proceeded to consider the other two items of their terms of reference, which together constitute a long-term programme for the Ordnance Survey. It is the final report dealing with these two headings that is to be discussed to-day.

The Committee's recommendations under these two heads can be divided into three categories which I may call respectively basic, consequential, and subsidiary. The basic recommendations are five in number: (1) that no alterations should be made in the scales of existing maps, or in the styles of small-scale maps; (2) that all Ordnance maps, large-scale as well as small, should be arranged on national, instead of county, lines; (3) that a grid be added to all Ordnance Survey maps; (4) that the revision of the 1/2500 map should be a continuous rather than a periodic process; (5) that a new map on the 1/25,000 scale should be introduced.

The consequential recommendations are: (1) that the change from county to national sheet lines should be the occasion for a complete overhaul of the large-scale survey, in which any discrepancies at the boundaries of projection systems, and any errors that have crept into the survey in the course of its revision, should be eliminated; (2) that large-scale plans should be square in shape, each 1/2500 plan being 1 kilometre square, each 6-inch plan 5 kilometres square, and each 1/25,000 plan 10 kilometres square; (3) that the international metre should be the unit of measurement for the grid; (4) that the expansion of the staff of the Ordnance Survey should be continued at the maximum practicable rate until the Committee's recommendations have been made effective, and that thereafter the work of the Ordnance Survey shall be adequately maintained.

The subsidiary recommendations are: (1) that additional contours should be added to the 6-inch map; (2) that a survey on the scale of 1/1250 of urban areas should be considered when the arrears of 1/2500 revision have been overtaken; (3) that the Government should consider the formation of a special Air Survey Unit capable of satisfying the requirements of the Ordnance Survey, and that short-term air photographic contracts with civil firms should not be continued as a permanent policy; (4) that the numbering of parcels on 1/2500 plans should be discontinued; (5) that the archaeological work of the Ordnance Survey should be continued on its present lines; (6) that the existing arrangements for revising the 1-inch and smaller scales should be continued.

There are two other points referred to in the body of the Report but on which the Committee have not made any special recommendations. These are: (1) the responsibility for carrying out the research work in survey; and (2) the establishment of additional tidal stations round the coast of Great Britain. It may be recalled that the Society's written evidence to the Committee referred to the desirability of making provision for research work in surveying; and it was suggested later, in oral evidence, that this should be entrusted to the Ordnance Survey, possibly in collaboration with the National Physical Laboratory. With regard to the question of tidal stations, evidence was offered to the Committee of the desirability of establishing additional stations, but the reasons given were mainly concerned with oceanography and

did not concern the Ordnance Survey directly. The Committee did not consider therefore the question came within their terms of reference. They mentioned however that if it were decided by the Government to establish additional stations the Ordnance Survey, which already maintains two such stations and has the necessary experience of the collection of tidal records, "might well be asked as a matter of practical convenience to undertake their maintenance."

The Report explains the reasons for each of the recommendations clearly and fully: I need not repeat them here. I would like however to explain the reasons for my classification, as I think this helps to understand the Committee's work. First among their recommendations I have placed that recommending that there should be no change in the scales of existing maps. Next comes the recommendation to substitute a national projection for our present collection of county projections. Some of the objections to the present system are illustrated by the exhibits here, and I hope there will be general agreement that this is a desirable change. It will however involve a change in the sheet lines of every single large-scale map. It will not be possible to retain even one of the existing projections, because the Cassini projection, at present used for all large-scale maps, is not suitable for the wide extension necessary to cover the whole country. If every large-scale sheet is to be altered, it will obviously create an opportunity for making such other alterations in our cartographic system as may be desirable. If made at all the change should, in the Committee's words, be "total rather than partial." They recommend, in short, that the old cartographic structure should be demolished and entirely rebuilt. There is then a freer hand in designing the new structure than there would be if the Committee had recommended only that the old edifice be patched up. This is why I have called this recommendation basic.

When the Committee consider the design of the new structure, their recommendation is that all the new Ordnance maps should be gridded. I do not suppose that any one who has had experience of map grids has any doubt as to their usefulness. I will not elaborate this point, since the Society has already discussed the subject more than once; the Committee too mention a number of the uses of a grid in their Report. If however the new cartographic structure is to include a grid at all, a whole set of consequences follow; such as the square shape of the large-scale maps and the kilometre-square plan as the unit, or brick, with which the whole cartographic system is built up. This recommendation is therefore basic also. The Committee recommended (para. 9) that the 1-inch map should be published in gridded and ungridded editions. I have brought here an example of what the gridded edition will look like, and I hope that it will be agreed that two separate editions will not be necessary.

The next recommendation is the change in the method of revision. Systematic surveying is still such a recent event in the world's history that I believe the Ordnance Survey is the only national survey that has as yet any considerable experience of map revision. Doubtless the Ordnance Survey still has a good deal to learn, but we have realized that when the original survey was finished the work of the department had only just begun, and that problems of revision are very far from being the same as those of the original survey.

The recommendation that the revision of the 1/2500 map should be a continuous rather than a periodic process will involve a change in our method of revision. How great a change cannot be appreciated by any one not familiar with our present technique. The system envisaged is described in general terms in the Committee's Report (paras. 52, 53), but there are a number of details still to be worked out. In 1928 I read a paper on the subject of revision to the Empire Conference of Survey Officers, in which I mentioned some of the technical problems of continuous revision, and although there was at the time no prospect of any changes, research in this matter was started by the Ordnance Survey soon after, and has been continued, with occasional interruptions, ever since. There are still difficulties to be surmounted, but I am satisfied that continuous revision is technically practicable, and I advised the Committee to that effect.

The main problem is to substitute a method of correcting the manuscript plan for the old practice of redrawing it *in toto* at each revision. I have brought here a few small specimens of drawings on metal sheets to show you what we contemplate. The surface of these aluminium plates is very resistant to corrosion. Ink can be dissolved off it with acid without injuring the surface. It is easier therefore to go on making erasures, etc., from these plates than from paper, while the plate is, for practical purposes, non-distorting, a most important consideration in a document that may be required to last for many years. It may be that we shall find some even more suitable material than metal plates for our drawings. I am confident that when our large-scale manuscripts have been transferred from paper to some non-distorting material on which corrections can easily be made the cost of revising the large-scale plans will be very substantially reduced. This recommendation also has a number of consequences which lead me to place it in the basic category.

With these remarks I will pass on to the matter dealt with on p. 9 of the Report, where there is a short discussion (para. 27) on the desirability of making changes in the scales of existing maps. The Report points out that "to all who have to use maps of more than one scale a series of scales related in some simple ratio is obviously desirable. . . . The relationships which permit of the most rapid calculation are binary and decimal. . . . From the point of view of the cartographer and the technical map user the ideal series of scales would be natural fractions in a binary or decimal relationship, *e.g.* 1/1250, 1/2500, 1/10,000, 1/25,000, 1/50,000, 1/250,000, etc. In such a series of maps the grid squares on all maps would be of two standard sizes, one double the other, thus simplifying measurement, and the actual plans themselves in the large scales would be of the same size, thus enabling the production of maps to be standardized and economies effected." In the above series the figures 1/10,000 should be replaced by 1/12,500, since 1/10,000 does not stand in a binary or decimal relationship to the other scales mentioned, nor would the grid squares on that scale be exactly twice the standard size. Probably this is a typographical error and 1/12,500 was intended, since the merits and demerits of the 1/12,500 scale are discussed later. The advantage of the 1/12,500 scale as compared with the present 6-inch, or the 1/10,000 scale, is that the grid square would be exactly twice the standard size and that the measurement of grid references or coordinates could be done with the scale,

or coordinate card, used for all the other scales, or indeed with any metric scale. A map sheet exactly standard in size with the 1/2500 and 1/25,000 sheets would be a very great convenience to all who have to use and store more than one scale of map. It happens also that the standard size is a somewhat more convenient size for outdoor use than the larger sheet of the 6-inch scale which the Committee decided to recommend. The fact that 1/12,500 happens to be almost exactly 5 inches to 1 mile may commend it to those who have a preference for inches to the mile, while another point, which might commend it to an even larger circle, is that the sale price of the 1/12,500 sheet would probably be sixpence less than that of the 6-inch sheet. The advantage of this particular scale is therefore not only a matter of economy in production, which is after all a minor point in comparison with the convenience of the user.

The Committee considered all these points, but came to the conclusion that as the 6-inch scale had been in use so long, was so well established, and above all had been used for so many important records, these very considerable advantages must be forgone. They mention that "any change suggested to those giving evidence before us has been received in a spirit of passive acquiescence rather than of active approbation." Their recommendation to retain the 6-inch scale is however qualified with the remark that it is not intended "to preclude the publication at some future date of a limited number of maps on the scale of 1/12,500." Although I think it may be agreed that there is at present no desire on the part of users of the 6-inch map for any change (indeed there would probably be very considerable opposition), on the other hand it is likely that all who have to use the grid, or to use a smaller scale map in conjunction with 1/2500 plans, would find the 1/12,500 scale definitely more convenient, as well as cheaper, than the 6-inch; and it may be conjectured that the number of such users will increase as time goes on. The advantages of this change of scale are largely dependent on the existence of a national grid and the extent to which the public makes use thereof.

Another change of scale which would, I believe, be advantageous to users of the grid would be the substitution of the scale of 1/250,000 for the existing quarter-inch. This change amounts to an increase in size of about 1^{1}_{2} per cent. only, and would be inappreciable to those who like to estimate distances in inches. I have never seen any one using a foot rule to measure distances on a quarter-inch map. On the other hand for those who wish to use the grid it would be a definite inconvenience to have a grid square slightly smaller than the standard size. The quarter-inch map (or 1/250,000) is used for a variety of index diagrams on which measurement of coordinates is sure to be wanted. It will probably prove necessary to publish index maps on the 1/250,000 scale even if the topographical map were exactly 4 miles to 1 inch. The fact is that the 1/25,000 and 1/250,000 are the natural derivatives of the basic 1/2500 scale in any cartographic system incorporating a grid. The Committee have recommended the introduction of the former, albeit somewhat tentatively, and I am disposed to think there is a good case for the latter as well.

With regard to the recommendation about air photography, this might be discussed in connection with the suggestion made in the Society's evidence

that more definite steps should be taken for carrying on research in survey, since the principal items of research that the Society had in mind were connected with aerial surveying. I think some of the advocates of a more energetic policy of air survey research have assumed that if an organization for dealing with the cartographic side of air survey had been built up it would have been easy to keep it supplied with photographs. If that is so, experience has not borne out their belief. Official policy in regard to air photography has hitherto been based on the principle that the air photographic work required by the Ordnance Survey cannot be undertaken by Service units, and must be done by civil agencies. Several attempts have now been made to get air photography done for the Ordnance Survey in this manner, by placing short-term contracts. The Committee's recommendation "that the Government should consider the formation of a special Air Survey Unit" was based on the experience gained from these. If some people have thought that we have been slow in making use of these new methods, I can only reply that the Ordnance Survey would not be justified in forming and equipping a big organization for surveying by aerial methods until better arrangements for the supply of suitable photographs than exist at present have been made. I have no doubt that at the present juncture air photography could be of great value to the Ordnance Survey, but in deciding its policy the Ordnance Survey cannot think only in terms of present junctures. It cannot even work on four or five-year plans; it has to look a good deal further ahead even than five years.

The relevant paragraph in the Society's written evidence on the subject of research ran as follows: "The first duty of the proposed research department might be to establish in England one or more of the most successful Continental models of stereoplotting machines, and to undertake a serious trial of them based upon the wide experience now available from other countries." The evidence went on to say: "There has been a tendency in this matter to say that if ever the method is to be employed in Great Britain it must be with machines designed and made in this country. This seems to be a distorted application of a good general principle."

The Committee made no reference to this recommendation in its Report. They were not survey "experts," and doubtless did not feel competent to express opinions on so technical a question. As however the reference in the Society's evidence to the employment of the method in Great Britain implies its use by the Ordnance Survey I might comment on it myself. The conditions in this country are different from those in any other. "The experience now available from other countries," however useful, is therefore not directly applicable to ours. There are a number of reasons why a stereoplotting machine is not likely to be of much use to the Ordnance Survey. Most Continental stereoplotters are designed to work with a relatively dense trigonometrical control, and no such control is available in this country. The Ordnance Survey is engaged at the moment on a new triangulation, but it will be many years before a "control" of anything approaching the density envisaged by the designers of Continental stereoplotters can be provided. Such "control" as the Ordnance Survey could have produced in the past, or could produce at the present day, would not, in my opinion, justify the use of

any of the "most successful Continental models." So far as productive work is concerned we could not in fact give a plotting machine a fair chance of showing what it could do. I do not think that finality has yet been reached in the design of stereoplotters, and the fact that, since the Society's evidence was tendered to the Committee, the firm of Wild has produced a plotter quite different in design from its previous model seems to lend support to this view.

As for the suggestion that the use of aerial surveys in Great Britain must be made with machines designed and constructed in this country, this statement would be more correctly described as a distortion of official views and statements than as "a distorted application of a good principle." The Air Survey Committee has been the official body chiefly concerned with the production of British plotting machines, and it has been primarily concerned to develop a technique that can be used in war. Such a technique must obviously be one that does not depend on foreign instruments. Quite apart however from war considerations, important though they may be, I feel sure that members of this Society would be sorry to see foreign manufacturers securing a monopoly of air-survey instruments and apparatus. If aerial methods of surveying are going to be as useful as many people expect, British instrument makers ought to be competing in the world markets for air-survey apparatus, just as they compete now in the market for ordinary surveying instruments like theodolites and levels. I think this Society should do what it can to help them. Foreign stereoplotting machines, evolved mostly by people who were instrument makers first and surveyors afterwards, are nearly all designed as "universal" instruments, that is to say, to work with any kind of photographs that will give stereoscopic impressions. They have to allow for wide departures from the simplest condition, when the stereoscopic impression is formed by two photographs taken parallel and perpendicular to the base. In other words Continental plotters presuppose in the photographs considerable random tilts which have to be discovered, and corrected for, by the plotter. In my view it should be possible to get as good, or better, results with a simpler technique and cheaper instruments by eliminating tilt as far as possible when taking the photographs. We know from experience that skilled aircraft crews, using suitable equipment, can reduce random tilts to less than half a degree. When air photography is being applied to the systematic survey of a whole country, and not only to isolated surveys of small areas for particular purposes, it is reasonable to count upon having skilled aircraft crews and suitable equipment.

I would like to mention one other point which the Committee deal with in para. 54 of the Report. This concerns the functions of the National Survey. The cost of the Ordnance Survey is only partly covered by the sale of maps and debits against other government departments. About half its gross cost is a charge against the Exchequer. It is pertinent to inquire what value the public gets for its money. I wish Lord Davidson had been here to answer this question, since if I try to do so my answer may be discounted as biased. The reason why I would like to draw attention to this paragraph in the Report is that, both in this country and in India, I have more than once seen the work of the National Survey slowed down in the hopes of easing a strain on the

national finances. I do not think this has been sound economy. The Committee's view is that "modern government in a country such as our own, demands up-to-date and accurate maps, and that out-of-date maps cause so much inconvenience and expense to users that whether directly or indirectly the full cost involved in continuous revision must inevitably be incurred." The fact is that good maps make for efficiency, and enable economies in time and money to be effected in a great number of administrative, economic, and other activities. These economies are spread over a very wide field, and I believe that their total soon surpasses the cost of map production. The case for producing maps at public expense is that it is much cheaper to make a single survey that will serve every purpose than a number of separate surveys each for a single purpose and costed against that one. Surveying is a slow process, and if its commencement is postponed until some particular need can be foreseen it will always be too late, and some wasteful and inefficient expedient will have to be adopted, or the advantages of a survey forgone altogether. The 1/2500 survey of Great Britain took approximately forty years to complete. When it was started no one could possibly have foreseen all the uses to which it is now put. I do not think any one—at any rate any one who heard the evidence tendered to the Departmental Committee—would contend that it has not justified its cost. If this is the case, it follows not only that its maintenance at public expense is justified also, but that reductions in Ordnance Survey staff, which make its proper maintenance impossible, such as were made fourteen or fifteen years ago "in the interests of economy," are not really economies to the country as a whole, whatever they may be to the Exchequer.

In conclusion I would like to recall the words of a previous Departmental Committee on the Ordnance Survey. The Committee of 1892 closed their Report with the following words:

"The great necessities of the Survey are obviously completion and early revision, and with these necessities not even any suggested improvements should be allowed to interfere. But should the sums which we have proposed for the purpose of revision be granted, and should the various recommendations which we have suggested be carried out, we confidently anticipate that the public will have no reasonable grounds for complaint as regards this great national work."

After Brigadier MacLeod had opened the discussion, the following speakers contributed:

Major-General D. F. ANDERSON: Speaking as a member of the Committee, I would like to say that Brigadier MacLeod's introduction is entirely satisfactory. He seems to have summarized extraordinarily clearly, and in a short time, the principal recommendations and views expressed in the Report.

As the representative of the War Office on the Departmental Committee I was glad to hear that the requirements of the civilian map-users do not differ materially from those of military map-users. It has, I think, sometimes been suggested that the military connection with the Ordnance Survey might not be altogether to the advantage of the country generally, but from the evidence the Committee heard it appears that we in the Army want exactly the same sort of maps as civilian users. We do not use large-scale plans very much except for

our Works services. Ordinarily we use medium-scale and small-scale maps exactly the same as those used in civil life. We use in addition the 1/25,000 which the Committee thought would also be useful in civil life. So, broadly speaking, there does not seem to be any difference in the respective requirements of the Army and civil users.

Since the Great War we have always had a grid put on our maps because we require it for military purposes. The Committee came to the conclusion that a grid would be valuable for other users also, and naturally we in the Army are very satisfied with the grid selected, especially that the international metre has been adopted as the unit of measurement. It was not recommended because we wanted it for military purposes, but because it was made quite clear by Brigadier MacLeod as our adviser that it is the most suitable for all purposes.

It is not, perhaps, always realized by those interested in maps or in particular aspects of surveying that there is extraordinary variation in the requirements of the different map-users. The Committee heard a good deal of evidence, and it was surprising how opinions differed. Maps are required for different purposes, and people have been in the habit of using maps of a particular kind or in a particular way. They do not like change. Indeed, we hardly ever in the evidence given before the Committee found any real consensus of opinion in favour of any changes we suggested, whereas often the consensus of opinion was in favour of leaving things as they were. When some perhaps think that the Committee have not gone as far in their recommendations as they might have done, it should be borne in mind that there are so many who use maps in various ways for their own special purposes and that we are so much committed by what has happened in the past. Certain kinds of maps and particular scales have already for long been in regular use. The Committee gave much consideration to the 6-inch scale, and we felt in the end that we could not recommend its abandonment straight away. That however is a question of time. So with some of the other maps at present in use.

I am sure every member of the Committee would agree that the maps produced by the Ordnance Survey are, as a whole, satisfactory and compare very favourably with the maps produced by any other country. All the criticism made by witnesses was of detail and, of course, of the slowness of revision. That however is due largely to economies in the past, chiefly owing to the Great War. The maps themselves were not criticized.

If I may reinforce what Brigadier MacLeod has said, I should like to add how much it was emphasized that the money spent in this country on survey and map-making is not wasted. It is unfortunate that so often the Treasury in time of economic pressure has cut down the money available. Taxpayers may save, but the money merely comes out of somebody else's pocket. In modern civilization maps are wanted for so many purposes by so many authorities and individuals that maps of all sorts have to be provided, and they can be produced much more economically and satisfactorily by the Ordnance Survey. That came out very clearly in the evidence. I am sure everybody who knows anything of the subject will share the hope that there will not be undue economy in this connection in the future.

Brigadier E. M. JACK: I should like to add my congratulations to Brigadier MacLeod for his clear exposition of the Report, which appears to me to be a most admirable document. It bears throughout evidence of clear thinking and of a real grasp of the problems involved, many of them of a technical nature. Though one may not agree with all the recommendations, they seem to hold the balance very evenly between what is desirable and what is practicable and worth while. As time is short and there other speakers, I will confine myself to

the four points that appear to me to be of major importance. The first is that the 25-inch map shall be put on a single projection and that in the process it shall be overhauled; the second is the adoption of the national grid; third, that there be continuous revision; and fourth, expansion of staff until the Committee's recommendations have become effective and that thereafter such work shall be adequately maintained.

As regards the recommendation that the 25-inch map be on a single projection, I suppose every Director-General for many years past and every one who has had to do with 1/2500 plans which fall on county boundaries has longed for this reform. It is good to learn that it is actually in sight. It is no less important that opportunity should be taken to overhaul the plans. We have all known for a long time that the process of revising from the previous survey could not be continued indefinitely, and that small errors and distortions have crept in. I am sure it is a sound policy to take this opportunity to get the 25-inch map put in order.

With regard to the adoption of the national grid, it is evident from the applause which greeted Brigadier MacLeod's remarks on the subject that every surveyor will welcome having a grid applicable to all maps and having one reference. I am entirely in favour of the decision to adopt the metre as the unit. The metre is part of a decimal system of measurement, which qualification is possessed by none of our national units. The choosing of a unit for the grid can be, and usually is, productive of much discussion. Whatever unit is chosen, it, or the suitable multiple of it, will form squares of a convenient size on some scales and of inconvenient size on others. It so happens that the metric unit appears to be least happy when applied to the 1-inch map, and this is unfortunate, as the 1-inch map is one of the most popular as well as the most beautiful of our maps. The 10-kilometre square is much too large; the 1-kilometre rather inconveniently small. In spite of this however I was surprised to see, in the specimen published in the Report, how little the kilometre grid interferes with the appearance and legibility of the map. The area chosen near Farnham is very close country and it seems to me that if the map could stand a kilometre grid there, it would stand it anywhere. Since the publication of the Report a new grid has been printed in which the lines are fine dotted lines, and it appears to me to be most successful. I cannot now see any objection to applying this kilometre grid to the 1-inch map. I hope it will be found unnecessary to publish two editions.

On all other scales the squares seem to be of very convenient size. I wonder if the Director-General would tell us if it is proposed eventually to make the small-scale sheet lines conform to the grid?

During my tenure as Director-General of the Ordnance Survey I became more and more convinced that the only way in which to deal with revision of large-scale maps in these days of rapid change was to have some form of continuous revision. The difficulties are admittedly many, chiefly technical, as Brigadier MacLeod has explained. In my time we tried certain experiments, but our attempts were somewhat crude and have since been enormously improved by the methods which Brigadier MacLeod has explained. It will be wonderful when it is possible to keep maps of the country continuously up to date on these basic drawings on aluminium sheets, so that whenever the need arises it will be possible rapidly to print an edition which will represent the ground as it really is at the time.

The final recommendation is that the position of the Ordnance Survey shall be reviewed annually until the proposals have become effective, and (this seems to me the important point) that thereafter such work shall be adequately main-

tained. If this recommendation is carried out in future in the spirit which is intended by the Report, it should mean not only an end to the economies and fluctuations which have been the bane of the Ordnance Survey in the past, but also that the maintenance of the Ordnance Survey structure will be worthy of the great foundation which was laid by those who initiated the survey. The Ordnance Survey is a very great national undertaking and is worthy of adequate maintenance and upkeep. It is foolish to allow it to fall into disrepair, yet that is exactly what has been done in recent years. It is true we have a complete system of maintenance and revision for our maps. I believe we are the only country which has such a system, and we must be proud of that fact; but the system is not good enough for modern requirements. Brigadier MacLeod has explained how the maps may be anything up to twenty years out of date, and of course lately they have been very much more so. The Report is insistent not merely on remedying this state of things but on preventing its arising in future. In para. 61 the following words occur: "We wish to emphasize that it is of the utmost importance that a settled policy should be adopted in order that continuity of effort should be maintained in the future, and that the inconvenience and waste of time and money which has arisen owing to accumulation of errors may not be repeated."

Brigadier MacLeod has shown very clearly what false economy it is to be parsimonious with the National Survey. The Departmental Committee show that they are fully alive to this, and there are many indications that the nation and Parliament are beginning to realize it also. If therefore this last recommendation is carried out we may look forward to a better future for what many of us believe, with good reason, to be the finest survey in the world.

Sir CHARLES BRESSEY: The Report which has come up for discussion this afternoon is one which I have studied very carefully and which I very much admire. It is presented in a most readable form with excellent illustrations, and from that point of view alone I thought it a memorable document.

I happen at the moment to be President of the Chartered Surveyors' Institution, but any remarks I make in regard to possible changes in the Ordnance Survey maps represent my own views and not those of the Institution, because, like many other professional bodies, it has necessarily a very large conservative element desirous of maintaining traditions which have been cherished in the past. Any changes in the shape of maps are matters of considerable moment to professional men. They have chests of drawers suited to the particular dimensions of the maps they are used to and portfolios of the correct size, so that they naturally view with some apprehension any great changes in the shape and size of maps. They also have very fine sets of ivory scales. Those scales are not in metres, and consequently professional men are not so enamoured of metres as others may be.

Speaking for myself, I have had the pleasure of discussing many of these points with Brigadier MacLeod. I welcome most heartily the changes that are recommended, and I should strongly support Brigadier MacLeod in perhaps going a little further in regard to some points upon which I know he feels as strongly as I do.

The introduction of the metre is I think a great step forward. I congratulate Brigadier MacLeod on the extremely delicate manner in which it is done. The fact that the new 25-inch sheet will be issued in the shape of a square, representing 1 kilometre along each side, is a great step towards recognition of the metre as a measure which we must in the near future adopt much more widely than we now do. This smaller square sheet will be much handier in the field than the 25-inch we have been accustomed to. As one who often has to work in

the field on windy days I greatly appreciate the reduction of the size of those sheets. In a short time every one will agree with this reform.

I was discussing the matter of these alterations with a committee of surveyors, and great apprehension was expressed lest this should be the thin end of the wedge leading gradually to recognition of the metre as the most rational form of measurement we can adopt. We are a very conservative nation, but I believe that the best way of testing the advantages of the acre would have been to lock the doors and set the members of the committee a few sums in acres, roods, poles, feet, and chains. Unfortunately those old measures have the sanction of religion and poetry behind them. I remember discussing with a lady the use of the acre, and when I expressed an unfavourable opinion she said, "Don't you ever go to church?" I admitted that I did, being a churchwarden, and she then asked, "Have not you heard of 'God's acre' and the 'holy rood' and the 'chastening rod'?" I assure you that such ideas have great weight with the public, most of whom nevertheless would be terrified if given a sum in acres, roods, poles.

The square rod is I think $272\frac{1}{4}$ square feet. I ask any one who has anything to do with arithmetic what possible support they can give to a system which lands one in measurements and calculations of that sort. I also ask you to remember that an acre is 10 square chains, so that the side of a square acre is not a round number of yards or feet, but involves the square root of 10.

I was once discussing English measures with a Frenchman, and for the sake of argument and to introduce liveliness I maintained the great advantage of the English measures because they were all based on human capacity and human dimensions. For instance, the pint represents the appropriate draught of beer for a well-grown man. The yard is the stride of a well-built man, the fathom is his height, and the chain is the divinely appointed length of a cricket pitch. The Frenchman looked at me very solemnly and then said, "Yes, we too had some very excellent local measures, but unfortunately they are gradually falling into desuetude. For instance, there is the 'houplée.'" When I asked what that was, he replied, "Oh, that is the distance at which you can hear a man call 'Houp-là' on a fine day." I thought he had got the better of me, and dropped the discussion.

Let us hope that Brigadier MacLeod will ultimately succeed in reducing the 6-inch to the 5-inch scale. I have seen what the alteration involves, but I think the advantages outweigh any possible disadvantages of the change. However, having served government departments and come into contact with Ministers, I realize how cautiously the public have to be handled. I am sure Brigadier MacLeod is aware of the dangers arising out of difficulties of that kind.

Once more I congratulate Brigadier MacLeod and the Departmental Committee on the production of an admirable Report. There is only one question I wish to ask, purely for information, because I have not seen the aluminium sheets before: Are they entirely free from smudging as one works over them?

Colonel P. K. BOULNOIS: As I was privileged to attend the meetings of this Committee as technical adviser to one of its members, I already have a detailed knowledge of its work and of the reasons which led to those eighteen recommendations which appear on the last page of its Report. I am glad to have this opportunity of stating categorically that I find myself personally in complete agreement with every one of those recommendations. Particularly should I like it to be known that I entirely agree with recommendation 4: "that the international metre should be adopted as the unit on which the grid should be based," for Brigadier MacLeod, who has always been an advocate of the metre, has quite convinced me that in adopting that unit the Committee have been

wise. This is an old controversy and I shall have a certain amount to say later as to why I have come round so definitely to favour the metre.

In my view the whole of those eighteen recommendations are sound ones. I could have a great deal to say about each one; but partly because in my opinion they are the most important and partly because my conversion to the metre has been due to it, I propose to speak mainly about the "revolutionary" step advocated by recommendations 6 and 9, *i.e.* that the 1/2,500 plans and the 6-inch to one mile map should in future be square.

In the first place however the recommendation that the staff of the Ordnance Survey be eventually increased to some four thousand is, in itself, the most important of all because, as we all know, the bad state into which the Ordnance Survey maps and plans had fallen as regards revision was entirely due to the absurdly small size of the post-War staff. A large increase of staff can however only be obtained when the Government is willing to put down more, and in this case considerably more, money. Without about quadrupling the Ordnance Survey, it had been clear for many years that the serious arrears in revision would never be caught up, and it is also obvious that few of the eighteen recommendations now made could be carried out without a large increase in establishment. It is also clear that the main object of the Ordnance Survey, *i.e.* to provide up-to-date maps and plans, would not be achieved.

With regard to the adoption of the square shape for all large-scale plans, it is to my mind far from being revolutionary; it is so interestingly evolutionary that I cannot understand why we cartographers did not think of it before. A square map is as easy to read and to use as an oblong one, but no oblong map can hope to compete with the square when it comes to indexing. We in the Geographical Section have been so impressed by this indexing facility that whenever we initiate a new series of gridded maps we will in the future undoubtedly make them square. Titles will then follow the new Ordnance Survey system for their 1/2,500 plans by merely being a grid reference to the bottom left-hand corner. It is incomparably the best system of naming sheets. No one in this room, I feel sure, can tell me what is the number of the 1-inch Ordnance Sheet now north of Sheet 114. It is certainly not 104, or anything convenient like that. Actually I believe it is 106. With the square map and the grid system of titles, we shall all know that from sheet 255/316 we only have to ask for sheet 256/316 if we are going to the east, or for sheet 255/317 if it is the one to the north we require.

Further, with the square map or plan and all maps gridded, special index sheets will be a thing of the past, and, having been responsible during my time at the Ordnance Survey for the preparation of county index diagrams, I can tell you what an advantage this will be. It was always necessary to distort the sheet lines on those county diagrams in greater or less degree in order that the true incidence of some village or town, or more frequently of a parish boundary should appear. In future however every map will in itself be an index of all maps of larger scale than itself if these are of square shape. The 1-inch in particular will index all 1/2,500 plans and 6-inch sheets.

The advantages of a national reference system applying to all maps of this country on no matter what scale must be obvious. Some day indeed we may hope that members of the Society will meet each other at 2532/4161 instead of at cross-roads, or halls of scientific institutions.

The fact that the future 1/2,500 plan had much better be square has, in addition, had a very important repercussion on the old controversy of whether the unit for the grid should be the yard, the metre, or the mile. A plan 1000 yards by 1000 yards is just sufficiently much smaller than one 1000 metres by

1000 metres to make it too small. The balance of advantage between the possibility of buying a small plan at a small price and the disadvantage of more frequently having a property at the corner of four sheets is a very delicate one. Whether a square kilometre is going to be too small can only be a matter of future experience, but I think we should all agree that a plan just 20 per cent. smaller in area would be a nuisance. A plan a square mile in extent and with sides each 1 mile long might, on the other hand, be just a little too large to enable the price to be such that users of plans would never hesitate to buy rather than to trace. It is a nice point, and in some ways a square mile plan appeals as a good size; and of course the advantages of the mile as a grid unit on the small-scale maps are obvious. On the 1 inch to 1 mile map, which the Committee eventually decided should be retained, the size of a mile grid square is nearly ideal, and it is also good on the $\frac{1}{4}$ inch to 1 mile map. When motoring, distances on the latter map could be rapidly judged, and for statistical purposes it would be an advantage to have each square on your map a square mile.

The Committee fully realized the practical advantages of the mile and discarded it; and I entirely agree with their action in this matter, on the grounds—to quote the words of the Report—that "If the mile were to be employed as the grid unit it would have to be subdivided decimally into tenths, hundredths, and possibly even thousandths, artificial divisions not corresponding to any familiar unit; and this disadvantage outweighs the advantages that the mile otherwise has." I agree with this rejection of the mile square plan in favour of the kilometre square one and the adoption of the metre as the grid unit for three main reasons. First, the fact that the mile, being based on the English foot and yard, has no such stable standard as the international metre. Secondly, because on large-scale maps and plans it is certainly of value to have one's grid divisions something definite instead of 176 or 17·6 yards. And thirdly, and this is perhaps the most important reason, there is always the possibility that some day this country may adopt metric measures for all its activities. In such a case a mile grid or 10,000 yard square plans, whose sheet lines can never be again altered without vast expense and inconvenience, would be quite out of court. How much better now to adopt a unit which under all circumstances is both convenient and of comparatively certain permanence.

Sir CHARLES ARDEN-CLOSE: You will probably have noticed that every forty or fifty years the Ordnance Survey gets a good shake-up. It had one in the '50s and '60s. It had one under the Dorrington Committee in 1892, and it has had another now. That shake-up does much good. It provides an opportunity of taking stock, of seeing what is done and what can be improved, and above all of seeing whether the money provided by the nation is sufficient to enable the Ordnance Survey to carry out its duties. I find myself in almost complete agreement with all the recommendations of the Departmental Committee. I think, in particular, a sigh of relief must have gone up from most of us when we heard the scales were not to be altered. I think also we owe the Committee, and those who advised them, hearty thanks for recommending the scheme of a single projection for all scales for the whole country. It is a fine idea, and I am sure it will prove to be most valuable.

As to the suggestion for the new scale of 1/25,000, it will be interesting to see whether it takes on or not. I like the new size of the 6-inch sheet. I always thought the old quarter-sheet of the 6-inch was too small. The new size is nearly 10 square miles as opposed to 6 square miles, and that is a great improvement.

The paragraph on p. 8 of the Report dealing with the 1/M Map is entirely incorrect. The main facts are: the map was suggested by Professor Penck at the

International Geographical Congress of Berne in 1891. It was standardized by an International Committee which assembled in the Foreign Office in London, in 1909; and the resolutions then drawn up were accepted, with few modifications, by an International Conference, at which thirty-six countries were represented, at Paris, in 1913. The first Ordnance Survey map on this scale was issued in 1903. Perhaps I should add that the Society was much interested in the map, Dr. Keltie being an official British representative on the 1909 Committee, and Mr. Hinks at the Paris Conference of 1913.

The illustrations are useful as an adjunct to the Report. I must confess I feel a little regret for the loss of the fifth (Relief) edition of the 1-inch, produced when Brigadier Winterbotham was Director-General of the Ordnance Survey. I thought it a fine edition, and I should like to see something of the kind come back. I do not find that the specimen 1-inch in the published Report is as good artistically or as easy to read. I have, without any explanation, put this map before some officers of an infantry regiment, and they said they much preferred the Relief edition to read. However that is only a matter of opinion.[1] On the whole, it is a really valuable Report, and I think it has laid excellent foundations for the future. I feel the Ordnance Survey will start with renewed energy to carry out the decisions which have I hope the full support of all those who have studied the matter.

I thank Brigadier MacLeod for the excellent way in which he has described the Report, and as I am obliged to leave now, I ask Sir Gerald Lenox-Conyngham to take the Chair.

Mr. A. R. HINKS: I am sorry, that Professor Mason could not speak on this occasion, because it is certainly not for me to defend the evidence which was given by this Society to the Departmental Committee. That evidence was approved by the Council; it was given by the President of the day, Sir Percy Cox, and by Professor Mason. As Brigadier MacLeod has made certain comments upon the evidence, it would have been useful if Professor Mason could have replied. Brigadier MacLeod has however in his statement, which will be printed, discussed certain questions arising out of the Society's evidence on the importance of research in survey. He makes it quite clear that he has no use in the Ordnance Survey for plotting or contouring machines. Does he not think that something might be done in the way of contouring the hills of Scotland above 1000 feet? At present the 250-foot contours are surveyed and the 50-foot contours are interpolated. I cannot think that they adequately represent the real shape of the hills of Scotland.

There is a recent heresy that really accurate contours are not desirable; possibly they may not be required for military purposes, but they certainly are for scientific purposes. Even by that very exhaustive method of pegging out levelled contours and chain surveying them, which they used to use in the Ordnance Survey, it is not possible to get such good characteristic contours of steep rocky country as can be obtained by stereoscopic plotting of contours from photographs. The exact characteristic shapes of the contours, dependent upon the kind of rock that the mountains are made of, are from a scientific point of view very important, and it is sad to hear anybody suggest that there is no value in really accurate contours.

[1] Sir Charles Arden-Close writes that his remarks on the style of the 1-inch map referred to the specimen printed in the Report. Since that appeared the map has been altered, and in particular the heavy grid lines have been reduced in thickness and the tree symbols have been removed from the woods. The result is a much clearer and pleasanter map, which is a successful example of cartography and will probably meet with general approval.—ED. *G.J.*

Brigadier MacLeod has said that the principal duty of introducing the plotting machine into England has lain with the Air Survey Committee. The fact is, of course, that there is at present no plotting machine in use in England. It has always been the ambition of myself and others in this Society to see a plotting machine established here for dealing not only with precise air-survey photographs taken in gyro-controlled machines, but also with air photographs of a miscellaneous kind that do come into this Society in some quantity and which want to be worked up, not with an accuracy of the 1/2500 map but with that sort of reconnaissance accuracy that can be got from more casual photographs. For plotting of that sort the machine that works only with verticals is of no use. The universality of some of the machines is, from the geographical point of view, their great merit. They can tackle verticals, obliques, or horizontals: any kind of photographs whatever.

Brigadier MacLeod is interested from the military point of view in using plates which are vertical to within about half a degree. I cannot help thinking that in time of war, when it might not be easy to fly vertically over an objective, obliques might provide something useful. At any rate, from the geographical point of view there is a great future for obliques. The Society has photographs which cannot be plotted because there is not a stereoplotting machine in England, and we cannot always afford to pay for the hire of one on the Continent, though Mr. Michael Spender has persuaded the Mount Everest Committee to allot a certain amount of money to pay for the use of the new Wild machine to work up some of the photographs taken on the Mount Everest reconnaissance of 1935; photographs which have never yet been dealt with because there has not been a machine available in England.

I can tell Brigadier MacLeod exactly why the Wild machine is of advantage to us. It is because we have several series of photographs taken with different focal lengths. The great demerit of some plotting machines, including the one that has been contemplated in England, is that they work upon the goniometric principle, which in plain language means that it is only convenient to work with a photograph of one particular focal length. It is necessary to have a lens projecting the photograph back into the machine of the same focal length as the lens with which it has been taken. That is highly convenient when working on systematic surveys but highly inconvenient when working on all kinds of miscellaneous photographs. Therefore we welcome the invention of the latest Wild machine, by which it is possible to deal with photographs of any focal length within a wide range. The old Wild machine was beautiful, the only machine that I ever thoroughly understood, and I regret its passing. But it was impossible to enlarge it to deal with the larger photographs and wide-angle lenses now used.

Brigadier MacLeod has urged that the Society ought to encourage the use of British instruments. We have always purchased British instruments as far as reasonably possible. A little while ago the Instrument Committee issued a report which showed that more than £2000 of the Society's money had in the last ten years been spent to purchase British instruments and £40 in buying one foreign instrument. But there is a serious difference between English and Continental makers. The English maker expects you to decide upon the principles of the machine you wish to use. He will then design it as well as he can, and you will have to pay for it. If the machine has a defect, as new models nearly always have, the loss is yours. On the other hand, the rival makers in Germany and Switzerland spend their money and go on improving their machines until they have something which is practically perfect to offer. I have digressed a little, but the reply is relevant to some of the passages in Brigadier MacLeod's opening statement as it will appear in print.

In complimenting Brigadier MacLeod upon the introduction of the use of the kilometre I would like to hope that the International Figure may be used in calculating the grid. I do not know how far that is possible. Finally, I should like to ask whether Brigadier MacLeod has any confidence that the ink will not flake off his aluminium sheets in course of time.

Colonel H. L. CROSTHWAIT: I should like to ask Brigadier MacLeod if it is possible to carry out the revision of the Ordnance Survey within a reasonable time, without the use of air photography. In view of what Mr. Hinks has said, I would like to add that in a few months' time Aerofilms, Ltd., will be using in England an auto-plotter of Wild construction.

Mr. E. C. BARTON: I have great pleasure in being here because of the welcome reception that has been given to the suggested introduction of metric measures on British maps as an initial step towards the ultimate general use of these measures in this country. My reason for saying that is that I happen to be Chairman of the Decimal Association, which has been working for the last fifty or sixty years, and has included such warriors as Lord Kelvin and others, to try to rid this country of the difficulties experienced, mathematically, in handling our weights and measures.

As a personal matter I welcome the metric grid, as I have been engaged in making contour drawings of Snowdonia in perspective for stereoscopic purposes. In so doing, instead of using the old-fashioned vanishing points I used the Cartesian coordinates, and I found I had to make a grid. It had to be metric, because to make these calculations in miles, furlongs, and so on would be impossible. I only hope that the new grid maps will come into being in my time, so as to ease the production of such perspective maps in place of the relief models which were formerly much in vogue, but through unwieldiness and excessive cost have been driven off the market. For these reasons, and as a Fellow of the Society, I welcome the internationalization of our map-making.

Mr. S. H. BEAVER: As one of the small band of academic geographers present, and as a representative of the Geographical Association which submitted a memorandum of evidence to the Departmental Committee, I should like to reply to Sir Charles Arden-Close. He asked how the 3-inch map was going to take on. From the point of view of academic geographers, that is to say those working in universities with students learning geography, I can assure Sir Charles and the members of the Committee that we regard the new map as one of the principal points gained. The 3-inch map is capable of showing all the details at present given on the 6-inch map, and at the same time an individual sheet will cover an area four times as great as that depicted by the present standard 6-inch quarter-sheets. For those working in universities, and, I am convinced, for schools also, the 3-inch map represents a great step forward, and one which will have very beneficial results on our geographical education.

Brigadier MACLEOD: One of the first questions was as to the effect of the introduction of these changes on the small-scale sheet lines. Among the exhibits here there is a sheet and a new index diagram showing the incidence of the new kilometre grid on the 1-inch map. If and when the new metric grid is approved by the Minister we would propose, at a convenient opportunity, to alter the sheet lines of the 1-inch map and standardize them in one size of sheets. At the same time we intend to introduce a new method of folding, whereby, if one desires to study only a small portion of the map, it is possible to do so without opening out the whole map, as at present.

As to the ink on the aluminium sheets smudging or flaking off, those are dangers which we may not have entirely surmounted. It has been our greatest difficulty to get an ink that will not smudge and chip off. It may be that we

shall have to handle these sheets with special care, but they will be kept in the office and if we treat them kindly I hope that they will serve our purposes. We can only find that out by actual test.

As to the 1/25,000 map, the specimen is actually a portion of one of the War Office sheets on that scale, and the War Office 1/25,000 series does not of course cover the whole country. We had to select an area for our specimens in which there happened to be a sheet on this scale in existence. We might perhaps have selected a better one. I do not regard the specimen as a very good example, nor do I suggest that we shall follow that style exactly, though we shall do so in a general way.

I agree with Mr. Hinks that if and when we ever undertake contouring of the Highlands of Scotland, or indeed of many parts of England, the best way to do it will be by means of aerophotography and a plotting machine, though whether we shall be able to do it with a British or foreign machine I cannot say. I think it is worth mentioning that at the time the Society's evidence was given to the Departmental Committee we had no mandate to do new contouring. If the Report is approved we shall have that mandate, and if the recommendations as regards air photographic or air survey units materialize, I hope we shall have air photographs also; I trust that when that time comes we may be able to produce British plotting machines in this country to compete with foreign ones.

In regard to the Wild plotting machine, I agree with Mr. Hinks that it is probably the best if you need a universal machine. The point in my written paper was precisely that when dealing with systematic survey, as the Ordnance Survey has to do, it is possible to get a cheaper result by cutting out tilts as far as practicable in the aeroplane and not using a "universal" machine. I agree that for military purposes, when it may be impracticable to fly vertically over an objective, obliques may be extremely useful. From that point of view I am in agreement with Mr. Hinks.

As regards computations and the use of the International Figure, I am not sure whether that might not entail too much alteration of position. What we have done so far with our new triangulation is to get the best all-over fit of the new work with the old so as to avoid making large alterations in the position of existing points. We want to avoid changing existing maps more than is necessary. It is possible we may be able to use the International Figure in the new computations without difficulty, but I should like to think that over.

[*The following contribution has been received by the Editor, G.J.*]

Mr. F. J. SALMON: I should like to welcome the suggestion that there should be a new series on the 1/25,000 scale. The gap between the 6-inch and the 1-inch is quite a serious one; considered in terms of area it is 1 to 36. The 1/25,000 would be of the greatest value for regional planning and for a number of other purposes, while the education authorities have already stressed its importance in their evidence before the Committee.

The 1-inch is not at all an easy map for the beginner to read, as so many features that strike the eye have to be omitted. The 1/25,000 gives a much better picture of the ground, while its kilometre grid is of ideal size for teaching students the coordinate system of reference. It is to be hoped that, when maps are published with the national grid, coordinate reference will be taught in all schools where map-reading is in the curriculum. Everything should be done to teach the young to describe positions by the only really unambiguous method, and I should like to see the coordinates of every signpost in the country marked on it, in small figures that would not confuse the motorist, as soon as the new maps are published.

I also welcome the suggestion that there should be an air survey unit, for it is long overdue. There are of course companies which have done excellent work, but they should not be necessary in countries where there is a properly staffed Survey Department and where there is a Royal Air Force which could quite well do the photography if it had had training with an air survey unit. Survey work, like that of the Post Office, is one of those activities which a government department is in a much better position to undertake than a private company. Like a forester, a surveyor is working not only for immediate results but for the future. He is building a national monument, and cannot put accuracy and permanency in their proper relation to time and cost if he is continually worrying about dividends. There will however always be work for companies in the many areas, both in and out of the Empire, where there is no Royal Air Force to take the photographs or where the Survey Department has not the staff to deal with them. Canada makes the best use of her Air Force in peace time, and other parts of the Empire might well follow her example.

The CHAIRMAN (Sir GERALD P. LENOX-CONYNGHAM): It only remains for me to thank Brigadier MacLeod for his interesting paper and to thank also those who have contributed to the discussion. It is a great disappointment to me that Sir Charles Bressey has left, because we owe him particular thanks for his excellent contribution. His explanation of the way in which our old units are embedded in English life was most illuminating, and showed how delicately we have to walk when proposing any change. I am certain all present have learned a great deal from what has been said from different points of view. Some of it has been what we perhaps did not expect to hear when we came to this meeting, but that does not make it any less interesting. I ask you now to express your thanks to Brigadier MacLeod in the usual way.

INLAND WATERWAYS OF GERMANY

G. R. CRONE

SINCE the State took over the control of the German inland waterways in 1921, much attention has been given to their improvement; schemes which had been projected for years have recently been completed, and others are in course of realization. This activity is an acceleration of a policy which has been pursued with a varying degree of intensity since the foundation of the first empire in 1871. Transport of goods by river however had played an important rôle in German economy long before that date. During the Middle Ages the rivers were the most efficient medium for the exchange of goods. Germany, particularly in the north and east, is well provided with rivers which offered few difficulties to navigation by the craft of that period. From an early date the facility with which this natural system of routes could be improved by the building of canals was recognized, and small schemes were carried out in the seventeenth and eighteenth centuries. The industrial revolution and the development of the railway system rendered the unimproved waterways largely obsolete, and it was not until the close of the last century that serious efforts were made to evolve a system adequate to the demands of modern industry.

The hydrographical network however possesses one great disadvantage from the point of view of a unified transport system: its general direction is from south-east to north-west, and the rivers flow on roughly parallel courses. There is therefore no natural focus of waterways, such as contributed to the growth of the French state in the Paris basin, and no continuous water route from east to west. Moreover the Oder debouches into the Baltic, and the Elbe and Weser into the North Sea, while the marginal position of the Rhine prevented its passing under complete German control, and its estuaries lie outside German territory. In addition therefore to the major conflict evident throughout German history between expansion north-westwards down the rivers to the sea, and expansion south-eastwards down the Danube, there was the divergent attraction of the Baltic. These centrifugal forces, which contributed to political particularism, had also an economic aspect, and until national unity was fashioned little advance towards a common economic policy was possible, and even less to a unified system of inland water transport. To-day it is the policy of the administration to resolve these conflicting trends, to unify the system, and to extend its sphere of influence.

To understand the work at present in progress and the plans for the future, a short sketch of the German inland waterways may be useful. The following notes are based in part on recent articles in German periodicals.[1]

The foundations of the network are the navigable rivers. Owing to the

[1] See for example, Siedentop, I., "Probleme der deutschen Binnenschiffahrt" (*Z. f. Erdkunde* 4 (1936) 749) and "Das zukünftige Netz der deut. Binnenwasserstrassen" (*ibid.* 6 (1938) 33); Keller, H., "Die in 1934 im Bau befindl. Wasserstrassen des Dt. Reichs" (*Petermanns Mitt.* 80 (1934) 180); Markmann, F., "Das deut. Fluss- und Kanalsystem" (*Z. f. Geopolitik.* 14 (1937) 403). A useful general sketch was contributed by P. Fischer and A. Desaunais to *Les Études Rhodaniennes* 7 (1931) 51.

physical character of the German plain, arising especially from its late glacial history, the northern portions of the rivers lack well-defined beds: their courses are tortuous, with low banks and wide flood-plains. The task has been first to reconstruct their beds, so that their length is reduced and the flow confined within definite limits. The branching tributaries make the interconnection of the basins simple, and the topography offers no serious obstacles to building canals. The second problem lies in maintaining the required level during the low-water season in summer, which is achieved by the construction

of storage dams. Navigation is sometimes held up by ice during the winter. In the period 1900–17 there were on an average nineteen "ice-fast" days a year at Frankfurt on the Oder, and six days at Magdeburg on the Elbe; the western rivers however are scarcely affected by ice. The whole system may be regarded as falling into two sections, a northern, comprising the lower courses of the rivers and the linking canals, and a southern, formed by the regulated upper courses of the rivers through the central highlands, which feed the former; or into an eastern section, the Elbe–Oder and its links, of which the more important are the Oder–Spree, Hohenzollern, and Trave canals, and a western section, the Rhine system with its supplementary canals, particularly the Dortmund–Ems and Ems–Weser canals. The upper

course of the Weser has up to the present been neglected, largely because, apart from navigational difficulties, it does not serve an important industrial region. Until the recent completion of the Mittellandkanal, referred to below, these two sections were separate.

The total length of inland water routes is approximately 13,000 kilometres; about 7500 kilometres are of first-class importance, and of these some 2500 kilometres are canals. The Elbe–Oder system comprises about 2600 kilometres; and the Rhine section, if the Weser is included, about 3250 kilometres. Vessels of 600 tons can navigate most of the western section; practically all the new canals described below however are designed to accommodate barges of 1000–1250 tons. In the east the average is about 400 tons.

The Elbe is the important component of the eastern section. Work is being carried out which will ensure a minimum depth of 1·40–1·70 metres, so that the entire waterway will be navigable throughout the year by 700-ton barges. Its chief function is to link the north German plain and the port of Hamburg to Berlin, which is reached by the Havel. By way of the Hohenzollern and Oder–Spree canals it is also in communication with the Oder. The river is navigable as far upstream as Praha, and has served as an outlet for Czechoslovakian traffic. In recent years it has declined somewhat in importance owing to strong railway competition. Steps have been taken however to modernize the Trave canal which connects it with Lübeck; the completion of the Mittellandkanal will doubtless increase its traffic; and the reconstruction of the Saale as a waterway and its junction by the Saale–Elster canal with Leipzig will also add to its importance.

The second component is the Oder. In the past difficulties to regular navigation have been great. The river falls to very low levels in the summer, interrupted by sudden and severe flooding. A number of dams have recently been built on the left-bank tributaries coming down from the Sudeten mountains to reduce this danger. The critical portion of the river is between Breslau and the junction with the Warthe. The flow is now controlled by the recently built storage dam at Ottmachau, on the Neisse, which has a capacity of 140 million cubic metres, and others are being built at Turawa on the Malapane and at Sersno on the Klodnitz. The immediate aim is to secure a minimum depth of 1·40 metres, allowing barges of 500 tons to pass when three-quarters loaded. The Oder is important as it serves the upper Silesian coalfield through the port of Kosel, and its value will increase on the completion of the new canal from Klodnitz to Gleiwitz and Beuthen, which will bring the Silesian coal-mining area in direct communication with the river. It also links the port of Stettin with Berlin *via* the Hohenzollern canal. The latter connects with the old course of the Oder at Liepe, near Oderburg, where a series of four locks, built in 1934, overcomes a difference in level of 36 metres. The right-bank tributaries, the Wartha and Netze, are navigable for small barges, and the latter is connected by the Bromberg canal to the Vistula. The Elbe and Oder systems carry approximately 35 million tons annually, about 27 per cent. of the total for the German waterways.

The Rhine is navigable for barges of 2500 tons up to Strasbourg, and for smaller craft to Basel. The Rhine system carries approximately one-half of the German inland waterway traffic (59 per cent. in 1929), the busiest ports

being those serving the industrial area of the Ruhr, particularly Duisburg–Ruhrort. This area is further served by the Duisberg–Dortmund and Lippe canals. As the estuaries of the Rhine are under external control, one principle of German economic policy has been to encourage exports from the western industrial areas to use their North Sea ports, at the expense of Antwerp and Rotterdam. This has led to very low rates on the German railways, and the same policy inspired the building of the Dortmund–Ems canal to feed the port of Emden. This has been only partially successful, on account of the dimensions of the canal; it has however been enlarged to accommodate 1500-ton barges, and carries approximately 7 million tons annually. The Ems–Weser canal links the Ems to the Weser below Minden, and thus affords communication between the Ruhr area and another port, Bremen, but by a roundabout route. The traffic on this route is therefore small, the figure for the combined Ems–Weser canal and the Weser being about 3·5 million tons. In order to bring the Ems into more direct connection with Bremen, the Küstenkanal, the most northerly of these links, has been built from the lower Ems through Oldenburg to the Weser. A more ambitious project is the Hansekanal: the complete canal will connect the lower Elbe at Horneburg to the Ems–Weser canal north of Osnabrück. The first section only, from the lower Elbe to the Weser at Achim, is at present contemplated. The completion of this scheme would bring Hamburg into closer connection by waterway with the western industrial areas, the distance, which *via* the Mittellandkanal is 750 kilometres, being halved. To complete the list of the smaller schemes in view for the Rhine system, mention may be made of a projected canal to link the Aachen industrial area with the Rhine, and a canal navigable by vessels of 1200 tons from Ludwigshafen through Kaiserslauten to Saarbrücken.

The first connection to unify the whole system is the Mittellandkanal, opened last October. This entailed the extension of the Ems–Weser canal eastwards from Minden to the Elbe below Magdeburg. Short branches connect it to the industrial centres of Salzgitter and Fallersleben. The canal is carried by a bridge across the Elbe to Burg, and a short branch canal with a series of locks communicates with the river at Rothensee, the average difference in level being 18 metres. Thence access eastwards is provided by the existing waterways. The canal was built to take boats of 1000 tons burden. Difficulty was experienced in providing a sufficient water supply to make good the loss, chiefly through evaporation. It had been proposed to secure this from the Hartz, but it is to be obtained by pumping from the Elbe. The canal, by way of the western canals already mentioned, thus connects the Ruhr with northern and eastern Germany. Its construction was for long opposed by powerful interests in the east, who feared competition from agricultural products entering through the Dutch ports. Magdeburg thus becomes the centre of the system of waterways. The reconstruction of the Saale–Elster waterway to the neighbourhood of Leipzig, referred to as the southern wing of the Mittellandkanal, which will open up that important industrial area, is also in progress.

The Kiel canal has an importance much greater than that of a unit in the inland waterway system, facilitating communication between the Rhineland and the Baltic ports. At present vessels up to about 35,000 tons can

pass through it. It has recently been announced that the canal is to be widened, the two locks improved, and the bridges heightened, to permit more of the largest vessels to enter it simultaneously.

The above brief sketch of the inland water transport system of Germany reveals certain existing gaps. Apart from the antiquated Ludwigskanal, there is no communication with the Danube; the Bavarian industrial region is virtually isolated, as are large areas of south central Germany; and direct, effective communication between the industrial areas and the North Sea ports is lacking. The projected schemes now to be discussed are intended to remedy these defects.

A company was formed in 1922 to construct the Rhine–Main–Danube canal, but for years the progress was slow. It was announced last year however that efforts are to be made to complete it by 1945. The work comprises three sections: the deepening and regulation of the Main from its junction with the Rhine to Bamberg (from Volkach to Eltmann however a canal will be cut); the reconstruction of the Ludwigskanal from Bamberg to Kelheim on the Danube; and the improvement of navigation on the Danube. The canal is being designed to take vessels of 1200 tons; as a result of the work already completed they can now navigate the Main to Wurzburg. The Main section will contain twenty-seven locks. The Ludwigskanal, built by King Ludwig of Bavaria between 1836 and 1848, naturally unfitted for present-day conditions (for it admits boats of 120 tons only, and its course is interrupted by one hundred locks), will be completely reconstructed. Works are also being undertaken to secure a minimum depth of 6 feet in the Danube, notably above Passau.

The object of this canal is clear: to bring the agricultural countries of the Danube basin into close touch with the industrial areas of western Germany, and so to facilitate the exchange of products. The completed system will still however possess the disadvantage that its northern terminus will be under foreign control. It is for this reason that an alternative to the Rhine section is being planned, by way of the Weser.

The navigation of the upper Weser has up to the present been neglected, and particularly on the two upper branches, the Fulda and the Werra. This neglect arises mainly from the variability of their hydrological regimes, but also from the absence of a highly industrialized area within the basin. The upper Weser is being improved to take 1000-ton barges as far as Münden, at the junction of the Fulda and Werra. The idea of connecting the Weser to the Main has been discussed for years: the Werra has now been chosen in preference to the Fulda for this link, as the Werra–Main watershed is the lower, and the Itz valley offers a good route to the Main. Work on river regulation between Münden and Wartha, near Eisenach, is now in progress. By training the river bed, cutting off meanders, etc., the distance between these two points will be reduced from 116 kilometres to 103 kilometres, and eighteen locks are being built. Plans are in preparation for the second stage to Merkers, the centre of the potash-producing area. At present the potash is sent to Münden by rail for shipment: the completion of this stage will cut out the rail journey, and so reduce export prices. It is possible also that the Werra may tap the industrial region of Thuringia, and that eventually a link

may be built between it and the southern extension of the Mittellandkanal, which would also open up this region.

The chief prospect for the Werra however lies in the completion of the Itz link with the Main. This, affording a junction with the Main–Danube canal, would place Bremen and eventually Hamburg in direct communication by water with south-east Europe. The advocates of this route argue that it would supplement, and perhaps ultimately exceed in importance, the Rhine–Danube canal, for its northern exit to the ocean would be under direct German control. It would however lack the advantage of tapping the industrial areas of the west.

Another plan for linking the Rhine to the Danube envisages a canal from the Neckar at Plochingen to Ulm. The Neckar has been canalized to provide an alternative outlet for the export industries of south-west Germany, and to supply hydro-electric power. The connection across the Swabian Jura to Ulm is likely to prove difficult as the canal must rise approximately 290 metres above the level at Plochingen in a distance of 60 kilometres.

A further scheme, which appears to have received an impetus from recent events, envisages the building of an eastern counterpart to these western links with the Danube. This is a canal from the Oder, at Kosel, through the Mährisches Pforte to Přerov and thence down the March valley to the Danube above Bratislava. This is the only route possible, but the crossing of the 1000-foot watershed presents considerable difficulties. Such a canal would remove to some extent the comparative isolation of the Silesian heavy industries from the markets of south-eastern Europe.

The above summary of the more important schemes in hand is evidence that Germany places considerable value upon an efficient system of inland waterways. Without attempting to estimate the ultimate success of the wider plans for uniting the Danube to the system, this reliance appears justified. In 1936 the internal water-borne traffic was over 115 million tons, compared with a railway traffic of 428 million tons. Recently the waterways appear to have gained upon the railways: in 1926 and 1936 the combined rail and water traffic was virtually the same at approximately 540 million tons, the proportion carried by water however rising from 18·8 to 21·3 per cent. The waterways are naturally preferred for heavy and bulky products, coal forming about 40 per cent. of their traffic, while 70 per cent. of the ores are transported by water. In considering the figures for water traffic, it is however necessary to bear in mind the predominance of the Rhine section and the share in it taken by foreign vessels. Measured on the basis of ton-kilometre activity, the traffic for all German waterways in 1935 was 22,514 million ton-kilometres, of which the Rhine accounted for no less than 13,024 million ton-kilometres. This predominance is explained by the favourable hydrological characteristics and the proximity of the Ruhr industrial area. Without the natural advantages of the Rhine, the rôle of the inland waterways of Germany would not be as important as it is.

In estimating the value of these schemes it must be remembered that in most cases they will be sources of hydro-electric power. They also will probably encourage the decentralization of industry. A speaker at the International Geographical Congress, Amsterdam, drew attention to the increase

in sea-going vessels of comparatively small burden, which, capable of penetrating considerable distances inland and not requiring elaborate port facilities, assist in the establishment of small industries away from the great concentrations. The regulation of the rivers has also freed large areas from the danger of floods and modified the water-table, to the benefit of agriculture.

Until the *Anschluss* it is understandable that the portion of the Danube in German territory, almost entirely isolated from the main system, took a very small share in the total traffic of the German waterways, its activity representing about 0·5 per cent. of the whole. The extension of German control over the former Austrian section, coupled with the improvements in its course between Ulm and Regensburg which are being carried out, will probably increase this share to some extent. But it is clear that substantial improvement in the Danube traffic is bound up with the success of the Rhine–Main–Danube and Neckar–Danube canals, which in turn depends upon the extent to which the exchange of German industrial products for the agricultural produce of the Danubian countries can be stimulated.

A NEW OROGRAPHICAL GLOBE

DAVID L. LINTON

THE fascination of a globe of special and technical interest for geographers is usually limited by its small size and the unrelieved smoothness of its surface. Consequently globes intended to appeal to a larger public outside the classroom and study have almost always been of large size and have frequently attempted some representation of the earth's major relief features. Such globes designed for exhibition purposes however have sacrificed detail and accuracy for effect, and so far as the writer is aware there has never been any attempt to produce a globe on a scale large enough to represent not merely the main outlines and larger relationships but also significant local detail, combining a faithful modelling of the surface of the lands with the highest attainable degree of accuracy. When a globe possessing these qualities was exhibited in the Royal Scottish Museum, Edinburgh, in September 1936, in an exhibition arranged in connection with the Edinburgh Congress of the International Union of Geodesy and Geophysics, it aroused considerable interest. This globe was made by the well-known Edinburgh sculptor, Mr. C. d'O. Pilkington Jackson. The copy exhibited in September 1936 has been purchased by the Royal Scottish Museum for its Geographical Gallery; a second copy of the globe is on exhibition at the Geological Museum, South Kensington.

The idea of making a 6-foot terrestrial globe in full relief arose out of the collaboration between Mr. Pilkington Jackson and Mr. F. C. Mears in the design of a fountain for the Livingstone Memorial at Blantyre, which included a hemisphere centred upon Blantyre, with the ocean areas represented in green marble and the continents modelled in relief in bronze. At the completion of the work on the Blantyre fountain Mr. Pilkington Jackson had at

his disposal a certain amount of apparatus and equipment, experience of the problems to be solved, and much enthusiasm for the larger project. Invaluable support was given at this stage by Mr. Rowatt, Director of the Royal Scottish Museum, who placed an order for the first completed copy of the globe. Although differing materially from the Blantyre hemisphere in character, the new globe was to be constructed on the same hemispherical template, using as far as possible the materials employed in making the Blantyre bronzes. This determined the actual scale of the globe, namely, 1/7,197,000 or 114 miles to an inch. Otherwise the two representations differ radically, for the highly conventionalized representation of relief could not be expected to serve the needs of exact science. It was partly to help the sculptor and his chief assistant, Mr. T. T. Bowie, in adapting their medium to the demands of exact cartography, and partly to ensure the accuracy and up-to-dateness of the information to be incorporated, that the present writer was invited by Mr. Rowatt to act in an advisory capacity on behalf of the Museum.

The completed globe is a plaster cast, constructed in several stages. The first was the building up in plasticine upon a wooden base of all the relief features that it was intended to show. This base was the hemispherical template which had been used for the Blantyre bronzes. For the new globe however there were two hemispheres, centred upon the two poles. From these hemispherical models plaster moulds were made. Seven were required for each hemisphere—six being quadrilateral sections of the spherical surface with an extent of 60° both in latitude and longitude, and the seventh section a polar cap of 60° diameter. The moulds were supported by a wooden framework which could be rigidly bolted together so that casts of each complete hemisphere could be produced. This sectional construction allowed the moulds to be removed individually after casting, so that projecting relief elements were not torn away. The casts were naturally imperfect in detail, as plasticine is incapable of receiving the sharp and accurate drawing of the high standard required. The surface had therefore to be reworked, and from each of the hemispheres thus carefully chased and refined a new series of moulds was made; these constituted the "types" from which all the replicas would be produced. For the final casting of finished copies from this second set of fourteen moulds all the sections of both hemispheres, save one, which had been designed to fall almost entirely in the water area of the Pacific Ocean, were bolted together. The sphere could be entered through the aperture left by the missing fourteenth segment, and the fibrous plaster which builds the completed globe was applied internally over the remaining area. The fourteenth section was then bolted in position and the plaster applied to it also, by working through an armhole left in its centre. In this way the globe is cast in a single piece. It is strengthened internally by a wooden framework supported by stays of mild-steel tubing. The latter radiate from a main diametral tube following the earth's axis in much the same way that the ribs of an umbrella radiate from the handle. The axial tube provides the means of mounting and of transporting the completed globe. By means of a removable eye-bolt at its northern extremity it may be lifted and carried, and by inserting an inclined spindle at its southern end it is mounted and may be rotated either electrically or by hand (Plate 1).

The sea-level surface of the globe is truly spherical, with a diameter of 5 feet $10\frac{3}{4}$ inches (1·797 metres). No attempt has been made to represent the ellipticity of the earth, since on the scale of the model the difference between the equatorial and polar diameters would be imperceptible. Neither has any consideration been given to the representation of the relief of the ocean floors. Submarine relief is still too little known to justify its inclusion on such a globe as this; the ocean areas are represented simply by the smooth spherical sea-level surface. The Royal Scottish Museum intends however to represent bathymetry by a series of graded tints of blue, leaving the land surfaces with their relief modelling uncoloured.

In the representation of relief many interesting problems arose. Experience gained from the Blantyre bronzes showed that an elevation of half an inch was quite adequate to represent the Alps, while on the same scale the Himalaya, 1 inch in height, looked imposing. Accordingly a vertical scale of this order of magnitude was chosen, and is actually twenty times the linear scale (*i.e.* vertical scale 1/3600; horizontal scale 1/7,197,000). In spite of this large exaggeration the relief effect has a high degree of naturalness. A smaller exaggeration would lead to the suppression of many features which a globe of this size would be expected to show; a larger exaggeration on the other hand would lead to absurdly over-steepened slopes and to increased practical difficulties in the removal of the moulds from the cast.

In the building up of the relief features in plasticine on the hemispherical wooden base, elevations had constantly to be checked, and to do this recourse was had to a simple device termed a "dip-stick." A circular arc of wood was cut with an arc-length of 90° and an internal radius some 2 inches greater than that of the globe. This was mounted on wooden rests at its two ends, so that when placed upon the surface of the sphere its upper edge was everywhere at the same height above the globe surface. The upper edge formed the datum from which measurements of altitude could be made downwards to the undulating surface of the land with a graduated vertical rod. The latter, a short steel knitting-needle engraved with a scale of 30,000 feet to an inch, formed the actual dip-stick. By resting the two extremities of the arc upon open-sea areas the intervening mountain masses could be conveniently straddled and their heights kept under observation as the work proceeded.

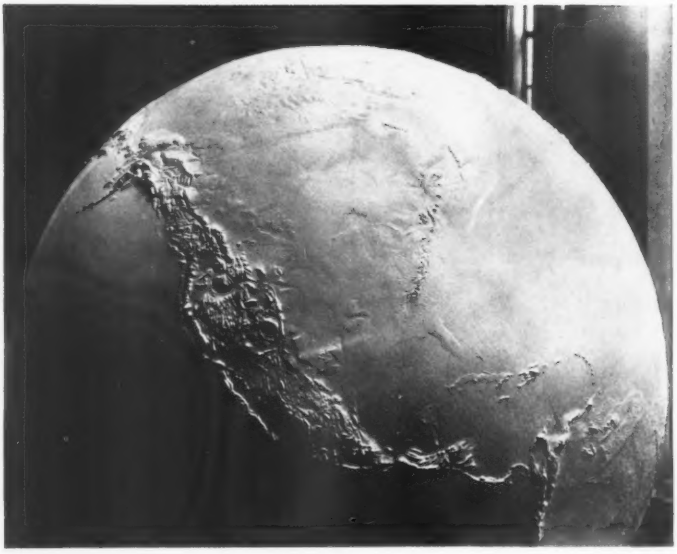
In its size and horizontal scale the new globe possessed possibilities of relief representation hitherto unattainable in older globes of smaller size, which could only indicate the location and magnitude of the larger areas of lofty elevation, the representation of individual features being practically impossible. Particularly is this true of the negative features of relief, the valleys that dissect the elevated masses. Even in the drawing of contours decreasing scale implies increasing generalization of outline, and in practice this involves first the suppression of the less important valleys, and ultimately the suppression of all but those of the first magnitude. Areas of high ground thus become exaggerated in size, losing their vital form, until, on the smallest scales, it becomes extremely doubtful whether the contour map is really suited to the representation of areas of strong relief at all. Relief globes in the past have, so far as we are aware, been founded upon a hypsometric map, and are therefore open to the same criticisms. Usually such globes have the

gores of a layer-coloured and contoured map pasted upon a surface already modelled in relief; and it is hard to say whether the colour is intended to assist the impression which the modelling should convey or whether the contrary is true. Both the modelling and the colouring, being based upon the hypsometric map, are similar in their possibilities and their limitations, and the information given by the one repeats rather than supplements that given by the other. The new globe however has a scale some three times larger than the largest globe of this type known to us, and this difference opens up entirely different possibilities of treatment. On such a scale features of the magnitude of, say, the escarpment of the Swabian Jura, the ridges and valleys of the Appalachians, the canyon of the Colorado, or the volcanoes of Japan or Mexico could receive individual and distinctive expression. This therefore was the basis of the plastic treatment, and individual features were modelled as cones, edges, vales, ridges, troughs, and the like, from a morphological rather than a hypsometric standpoint. Generalization is not thereby abolished, but it assumes a different guise: instead of smoothing out peaks, ridges, and intervening valleys into a more or less uniform area of high ground, these features are retained in the model, and impart to it much of its vitality. It must be emphasized that often only one feature is shown in a district where several of the same kind actually occur in nature; the rendering is faithful as to the type of surface configuration, but the limitations of a scale seven times smaller than that of the International Map are still very real.

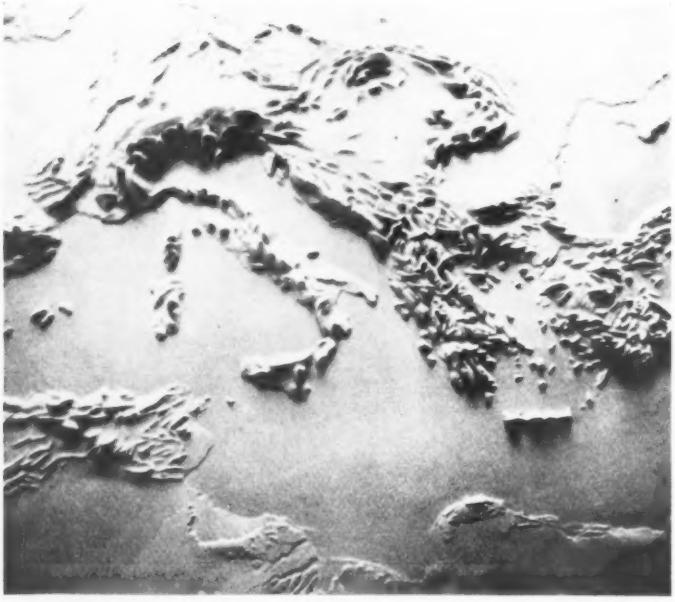
In order to carry out this plan it was necessary to provide the craftsmen who did the modelling with maps showing the exact nature of the individual features to be represented. The required maps were not relief but land-form maps; and since few, if any, suitable maps were believed to exist, they had to be constructed. Only in the case of Africa was it possible to utilize directly an existing map; for the remaining continents the writer constructed manuscript maps. It should perhaps be emphasized that rivers cannot be shown as distinct from the plains or valleys in which they flow; and that while the lands are generally quite readily distinguished from the sea areas, the shore-lines of flat coastal plain regions like Florida cannot be shown by the modelling. With a vertical scale of 30,000 feet to an inch, features with a relative relief of less than 1000 feet are difficult to model and, if they must be represented, can only be shown by means of colour. The skill of the craftsmen enabled this limitation to be overcome to some extent: scarps and incised valleys whose relief was as little as 500 or 600 feet were shown by inserting them on the plasticine model and partially erasing them from the first plaster mould.

Apart from questions of representation, the accuracy of the relief shown on the globe surface must vary considerably because of our unequal knowledge of world topography. Probably about half of the 57,000,000 square miles of land surface are sufficiently well mapped to be depicted on a globe of this size without serious error. For the remainder of the world however the inadequacies of survey are a real source of difficulty, and in a few cases of serious embarrassment. Sometimes it has meant working from a source map on a scale smaller than that of the globe, or from the partial records of explorers; and occasionally there has been no source at all. Solid representation cannot however be suddenly terminated; something must appear, even if

1. Complete globe with motor for rotation



2. North and Central America



3. The central Mediterranean and adjoining regions

probabilities replace ascertained facts. The only alternative is to await the adequate exploration of these blank spaces, of which there is at present no prospect. Fortunately they are practically confined to the interior of the Antarctic continent and some stretches of its coast-line, and are thus neither conspicuous nor vital.

These inequalities in the data lead to inevitable inequalities in treatment. Although every effort was made to secure unity in the modelling over the whole area, a shrewd observer might detect in some places greater freedom of generalization due to lack of detailed information. For Europe and the U.S.A. of course no such difficulties arose. Indeed in the case of Europe the embarrassing wealth of information made selection and generalization no easy task. Many excellent compilations however are already extant, and the published sheets of the International Map and of the corresponding series of the Royal Geographical Society, the 1/200,000 Austrian Staff map, the delicately hachured plates of Stieler's Atlas, and the morphological diagrams in the volumes of the "Géographie Universelle" and elsewhere were some of the principal sources from which information was taken.

In Asia the International Map continues far enough eastwards to overlap with the series "India and adjacent countries" on the 1/2M scale, and a few International type sheets are available for Malaya and for Japan. The latter could further be interpreted in the light of G. H. Smith's valuable physiographic diagram. For China, central Asia, and the East Indies, the British General Staff compilation on the 1/4M scale was an adequate source for reduction to the 1/7M scale, even if a little unequal in its different parts, and for China and Manchuria could be supplemented by reference to the Geological Atlas of Eastern Asia on the scale 1/2M.[1] Schokalsky's map of the Soviet Union is the most accessible representation of the recent views of the Soviet cartographers, but is only on the 1/12M scale. Fortunately it may be supplemented by the maps showing Obruchev's new interpretations of the mountains of central and north-eastern Asia published in this journal and the *Geographical Review*. For the Urals the representation given by Stieler seems trustworthy, and has been followed; while for the desert region of Arabia the recent French compilation on the 1/5M scale,[2] supplemented by reference to the exploratory maps of Thomas, Philby, etc., proved satisfactory.

In North America, the United States and the more accessible portions of Canada are of course well mapped, and the excellent physiographic diagrams by A. K. Lobeck, G. H. Smith, and Erwin Raisz proved very helpful. For Alaska the photo-relief map on the scale 1/2,500,000 compiled by the United States Geological Survey in 1923 afforded a graphic and convincing basis, and was fairly closely adhered to as regards the type of relief shown, though more modern information was used for the fixing of inland features in some instances. Greenland and the Canadian Arctic provided many problems, and even the Mackenzie basin is poorly mapped. Every attempt was made to utilize the surveys by many expeditions shown on maps scattered through the

[1] Published by the Japanese Association for Mineralogical and Geological Research. Tokyo, 1929.

[2] Carte dressée et publiée par le bureau topographique des troupes françaises du levant. Beyrouth, 1935.

principal geographical periodicals. Mexico and Central America were again sources of difficulty. By a comparison and conflation of the chief existing compilations—the sheets of the American Geographical Society's map in the International style in the areas for which they were available, the 1/2M map of Mexico, the principal atlases, and the 1/5M geological map of North America published in 1911 by the United States Geological Survey in cooperation with the Instituto Geologico de Mexico—it was possible to obtain a reasonably satisfactory view of the relief of these regions, and the interpretation given is practically as accurate as the scale will allow.

As has already been mentioned, Africa proved to be the only continent for which a suitable compilation already existed, namely the "Carte de l'Afrique au 5 millionème," published by the Service Géographique de l'Armée in 1935, and the representation of this continent is of a high degree of uniformity and a wholly sufficient degree of accuracy. The two remaining continents of the southern hemisphere however are far from being adequately mapped. South America is well provided in parts. The modern compilations on the 1/M scale made by the American Geographical Society were adequate for the areas covered by them, and the "Mapa hipsométrico de la República Argentina" on the 1/2M scale, published in 1930, was a most useful source. Brazil and the Guianas however are in large part inadequately known and mapped. The 1/M sheets of the Engineering Society of Rio de Janeiro were not available in Edinburgh, and in any case give but scant information of a morphological character. Comparison was therefore made of the existing atlas compilations with geological maps (*e.g.* of Minas Gerães), with the sketch-maps of explorers (*e.g.* in southern Venezuela), and with the interpretative small-scale diagrams included with published descriptions of this terrain (*e.g.* in the "Géographie Universelle"), and in this way a base-map was made from which the modellers worked.

A similar situation arose with regard to Australia. The official compilation for the whole continent is a hypsometric map of astonishing crudity, with a scale of 1/4,600,000, published by the Meteorological Department of the Commonwealth Government in 1918. While it provides useful information regarding altitudes throughout the continent, it is inferior to the existing atlas compilations for the settled regions, for which moreover some fragments of the International Map also exist. In a few cases valuable maps were available for particular regions (*e.g.* Madigan's representation of the Macdonnell ranges), but for a very large part of the continent recourse had to be had to a comparison of existing topographic compilations with the geological map, the latter being Sir Edgeworth David's valuable map on the scale 1/3,000,000. Finally for the Antarctic, as for the Arctic, regions the American Geographical Society's compilation of 1928 on the scale of 1/4M provided a basis which was corrected or supplemented by reference to the maps published by recent expeditions, more particularly in the Antarctic. For the loan of all these maps, without which the work could not have been carried out, the sculptor and the present writer are much indebted to Messrs. J. Bartholomew, to the Royal Scottish Geographical Society, and especially to Professor A. G. Ogilvie and the Department of Geography in the University of Edinburgh.

Two photographs of sample areas have been reproduced to indicate the

scope and character of the relief representation. Plate 2 shows the whole of North America, and though it is impossible to illuminate the entire continent satisfactorily, the photograph reveals very well the modelling of the Cordilleran region. Numerous morphological contrasts are clearly shown within the Cordillera which the older type of relief globe served but to obscure. We need cite only three: first the contrast between the giant peaks of the Alaskan knot and the maturely dissected plateau regions north of the Yukon river; secondly that between the strongly grained coast ranges of California and the massive tilted block of the Sierra Nevada; and lastly that between the Colorado plateaux rising tier upon tier, surmounted by volcanic peaks and slashed through by great canyons, and the sea of faulted blocks and aggraded interment basins whose wavelike forms seem to advance and break almost at the foot of the western and southern scarps of the plateaux. Such a synoptic view of the Cordillera moreover permits a juster appreciation of its major tectonic lineaments, and suggests unexpected structural correlations. East of the Rocky Mountains something may just be discerned of the delicate tracery of the incised river valleys of the Great Plains between Texas and the Mackenzie, and of the scarp-rimmed lowlands of Goshen Hole and the Pecos valley and the sudden interruption of the plains by the Black Hills uplift. Farther east the close-grained topography of the Oachita Mountains and of the folded Appalachians is just to be seen, and the conspicuous shadows cast by the residual masses which rise above the New England peneplain—the Green and White Mountains and the Katahdin group—are especially noteworthy. The fiord coasts of Labrador and Baffin Land are inadequately revealed by the photograph, but the smoothness of interior Greenland appears in real contrast with the rough west coastal zone and the high mountains of the east.

The second example (Plate 3) is chosen for its familiarity, and covers central Europe and much of the Mediterranean basin. An attempt has been made to show the variety of both the mountain and the lowland forms. The Alps, with their lofty ridges and groups of sculptured peaks divided by great continuous longitudinal troughs, contrast equally with the parallel ridges of the Jura and the Beskids, the jumble of fractured blocks and folds of the regions round the Aegean, the mingled ridges and massifs of the Algerian and Tunisian Atlas, and the lofty karstic ridges and plateaux of Yugoslavia. At lower elevations the fractured edges of the Hercynian blocks of central Europe may be recognized, the Cevennes, Vosges, Taunus, the Harz, Thüringerwald, and Erzgebirge, to name only a few; and the modern volcanic cones of Vesuvius and Etna and their extinct cousins of le Cantal, le Mont Dore, and the chain of Puys all receive individual expression. In the lowland areas, the Paris basin, Franconia and Swabia, and the Saharan and Libyan deserts may be discerned, and the contrast between the dissected low uplands and the true lowland plains of ice- or river-deposition may generally be made out, as notably in the contrasted regions adjoining the lower Danube in Bulgaria and Wallachia.

These examples will indicate the character of the relief representation and the radical manner in which it departs from the methods previously used in relief globes. The result is astonishingly convincing, and it is to be hoped that the globe will be deemed by all geographers to be scientifically successful.

JUNGFRAUJOCH RESEARCH EXPEDITION: PRELIMINARY REPORT

THE field work undertaken by Mr. G. Seligman's Jungfraujoch Research Party was concluded at the end of last September after five months' work on Great Aletsch glacier. The main part of the research concerned the study of the transition of snow into ice in glaciers, but in the course of it several other glaciological problems were to a greater or less extent clarified.

The general scope of the work and the results may be outlined as follows:

Transition of snow into glacier ice

Specimens of firn and ice were removed from the walls of deep crevasses and artificial shafts sunk in the interior of the glacier. Depths down to 100 feet below the surface were explored. The samples were conveyed in large Dewar flasks to the Research Station, where they were examined in a laboratory which had been excavated from the stationary ice close to the Joch. The temperature of the laboratory remained at about $-4°$ C. throughout the summer, so that samples could be collected and kept for long periods when necessary.

The change in density with depth was determined at various points between the source and firn line of the Great Aletsch glacier. A fairly conspicuous transition between firn and ice could be distinguished at a density of about 0·84, at which point the hitherto porous firn becomes impermeable to water. The formation of ice from firn is caused by the freezing of descending melt-water and by a slow process of settling of the individual firn grains. Measurements indicate that the latter process is an important factor in increasing the density without altering the grain size.

The glacier profile: the internal structure of a glacier

The investigations leading to the above results covered so wide a range that it was possible by means of them to draw a longitudinal section of the glacier showing the density distribution therein, and to mark upon it the transitional plane below which everything is ice and above which everything is firn. In this way some knowledge of the internal structure of the glacier has been obtained, and this in turn may throw new light on some of the still puzzling results which have been met with in seismic depth-sounding operations in glaciers.

Névé temperature

By means of thermocouples buried at depths down to 100 feet it was found that the winter cold wave penetrated to about half this depth. Below this point it is concluded that the whole glacier is at the pressure melting temperature. The heating of the firn in summer is attributed to a downward percolation of melt-water from the surface, and it has been found that the rate of temperature rise depends on the firn structure and its permeability to water.

Crystallographic studies

Using the standard methods of optical crystallography, the size, shape, and orientation of the crystals and the distribution of the air spaces were studied in thin sections cut from specimens which had been taken from the interior of the glacier. A statistical survey of the orientation of a large number of crystals in these sections gave evidence of the presence or absence of any preferred orientation. Although firn near the surface showed orientation due to growth in a unidirectional cold wave, this orientation was observed to disappear gradually at

greater depths by the independent movement of firn grains during glacier flow and settling. Preferred orientation of crystals by plastic deformation due to shear was found in several places on glacier tongues.

This is the first occasion on which any systematic crystallographic study of glacier crystals has been made. The results are most promising, and the clarity with which the habit of the different crystals could be observed and recorded has already proved of great value in assessing the various influences at work within the glacier, more especially in regard to the origins of the banded structure and the nature of glacier flow. The thin firn and ice sections were made by means of a special microtome loaned to the party by the Swiss Snow and Avalanche Commission. The sections, which it was possible to cut as thin as 0·2 millimetre, seen under polarized light were often of great beauty.

Ice and blue bands

The crystallographic investigations, coupled with daily measurements and observations of bands actually in course of growth in pits and tunnels excavated in the firn and ice regions, should go far to settle the age-long controversy on the nature of the banded structure of glaciers.

Two types of bands were observed in the *névé*: dirt bands, which form on the surface and represent the boundary between the accumulations of successive years, and ice bands, which are also of sedimentary origin; the crystal orientation of these is similar to that of pond ice.

Other types of bands are to be seen in glacier tongues. Of these, the most important to be studied were the "blue bands," which are of tectonic origin. Bands of sedimentary origin were also found in the glacier tongues.

Glacier flow

Here also the crystallographic observations combined with direct measurements in the glacier gave definitive results on the nature of glacier flow. Fundamental differences were observed between the mechanism of flow in the *névé* region and in the ice of the glacier tongues. In the former, it was possible to watch the actual movement from day to day of individual crystals or aggregates of crystals past their neighbours: true differential movement of units of firn. These observations confirmed the crystallographic evidence which had also pointed in this direction.

In the glacier tongues, where the interlocking of crystals prevents their differential movement, the mechanism of flow was found to be plastic deformation accompanied by laminar travel along thrust planes. Both these types of movement were observed and measured from day to day by a very simple but accurate method.

Mr. G. Seligman, Dr. T. P. Hughes, and Mr. M. Perutz are still engaged in correlating the very large amount of new material which the researches of the expedition have produced. They hope to publish preliminary physical and crystallographic papers in the near future, followed by glaciological articles in the course of a few months.

REVIEWS

EUROPE

REGIONAL SURVEY ATLAS OF CROYDON AND DISTRICT. Prepared and issued by the Croydon Natural History and Scientific Society. *Croydon: Roffey and Clark—London: Thomas Murby and Co.*, 1938. *Loose-leaf binder* 13 × 10 *inches, containing maps and letterpress.* 15*s* (8*s* 6*d without binder*)

A regional survey of the Croydon district was started in 1913, but only within the last few years has the Society concerned been in a position to commence publication of the results. This may seem slow progress, but financial reasons and the limitations of voluntary effort acted as a brake on the realization of the scheme. Even now the atlas is not complete, the sheets being published serially for insertion in a loose-leaf binder. It is not stated how long it will take to finish the task. Sets of the maps may be obtained by Education Authorities at special rates.

The survey is to be a comprehensive one, on the lines advocated by the late Professor Patrick Geddes. The actual classification of subject-matter was determined by Mr. C. C. Fagg, who is the prime mover in the enterprise, and embraces some nine aspects of the region, ranging from geology, meteorology, and hydrography to archaeology, economics, and sociology. For sake of simplicity and economy the Ordnance Survey was commissioned to print base-maps in light-grey ink on which the regional survey material could be over-printed. Two minor weaknesses of this method are revealed in the sheets so far issued: one or two sheets do not register very well, and in one sheet at least (the relief map, which is layered) the overprinting obscures the pale ink of the base-map. The maps are accompanied by a page or two of commentary and a bibliography. The instalments so far available include maps of geology, relief, hydrography, and population. Those representing the first three subjects have been compiled by Mr. Fagg himself, and are evidently the product of careful and intensive work. In the commentaries a most intimate knowledge of the locality is displayed. The author of the population maps, Mr. O'Dell, restricts himself to an explanation of his statistical methods and a note on the broader features shown on the sheets. The only archaeological map, devoted to the Roman period, is accompanied by three pages of references, classified to correspond to the numbering of sites and roads shown on the map.

As a coordination of the efforts of a local scientific society, and a means of arousing interest in local scientific work, this enterprise deserves commendation, and we trust that the Regional Survey Committee will see their publication complete at an early date. Other scientific associations and local geographical associations might well undertake similar atlases.

J. H. G. L.

A SURVEY OF THE SOCIAL SERVICES IN THE OXFORD DISTRICT. I. Economics and government . . . [Edited for a Committee by Miss A. F. C. BOURDILLON.] *London: Oxford University Press*, 1938. 9 × 5½ *inches;* xii + 380 *pages; maps and diagrams.* 15*s*

Barnett House, Oxford, most appropriately has a Survey Committee which is studying the revolution in the life of Oxford and its surroundings now so dramatically working itself out. In this volume the geography and demography form a brief introduction of forty-six pages, confined to rather bare statements

but with interesting diagram maps, several of which are folders. The growth of Oxford in olden times, as it can be traced in the street plans and names, is so interesting that one wishes that Mr. Gilbert had let himself go, especially as some of the points that could have been raised bear upon the matter in the demographic chapter. In that chapter, again, there are maps whose interest would have been far greater had the symbols, especially those for decreases, been more wisely chosen. The main topics of the book are however economics and government, and to these are added valuable appendixes occupying over eighty pages. Like Dr. Brinley Thomas in South Wales, the Committee has found the unemployment insurance books a valuable source of information which might be exploited by students in other areas. In July 1936 over ten thousand men and under one thousand women working in the vicinity of Oxford had books acquired outside the survey area, and some five thousand of these were directly employed in the motor industry. The spells of "short time" in the motor industry are a cause of some economic problems in the district, but a more dangerous feature is that widespread characteristic of a youthful industrial centre, a too large dependence upon one industry. The profits of that industry are to a most generous extent devoted to local activities, and yet do not protect the district against future fluctuations. It seems unfortunate that Lancashire's mistakes of the nineteenth century have not brought greater wisdom in this respect. The account of unemployment ceases with 1937, and the recession of trade in 1938 could therefore not be considered; nor is it possible to forecast what will happen when the specialized youthful labour strength of the motor industry reaches middle age and becomes less fit to cope with the methods of mass production. It would have seemed the way of statesmanship to try, in this case especially, to look to the future. One hopes the 'Survey of social services' may set thought moving in this direction.

The chapter on agriculture is done well enough to make it depressing reading. Communities with a long heritage seem to be weakening, and a fortuitous concourse of industrial atoms is developing here and there on a precarious foundation. This is perhaps the most important problem of the area, and indeed of Britain, and one hopes that those who survey social services will address themselves to the question of the rebuilding and maintenance of community life with the full realization that formal local government is not the essence of the problem. The references to voluntary services connected with administration are a welcome feature of the section on government, but there is need of more of the kind of thought that was put into the adaptation of Danish rural life to modern conditions. H. J. F.

RETURN TO THE BALTIC. By HILAIRE BELLOC. *London: Constable and Co.*, 1938. $9 \times 5\frac{1}{2}$ *inches;* x+192 *pages; illustrations* (*by Edmond L. Warre*) *and sketch-map.* 12*s* 6*d*

Mr. Belloc's return to the Baltic after an interval of forty-three years has led to a conversational book dominated by the idea that there has been only one culture in western Europe, and that the culture of his Faith. At a time however when the questions of the origin, the nature, and the future of European cultures are so urgent, their casual treatment in this book, of which accuracy and thoroughness are not outstanding qualities, is disappointing. Within a few sentences of his opening Mr. Belloc expounds his main thesis. "With every people of Europe outside the old limits of the Roman Empire there is a moment of origin to be discerned, a moment in which it passed out of the formless mist of barbaric paganism into the fixed culture of Christendom: a moment in which there came to it for the first time in sufficient strength the formative institutions of our

civilization, writing and record, the monastic centres, permanent building, and also, above all, the kernel of the whole affair, the Mass." A visit to the British Museum, or to the National Museum in Copenhagen, an acquaintance with pre-Christian Scandinavian history or even the evidence of the Iceland sagas make this description of all cultures before the impact of Rome as a "formless mist of barbaric paganism" a misleading generalization.

The author has his own theory about the spelling of place-names. We meet Aarhus as Aarhuis, Samsø as Samso; and after comparing the English version Elsinore with an alleged Danish word Helsingor, Mr. Belloc complains of the ugly native form; the correct form is Helsingør. The castle of Elsinore he calls Kronberg, instead of Kronborg; while King Christian IV, a great builder of noble castles, is not even mentioned. Thorvaldsen is spelt in the German way with a "w," and Ibsen (and this after all is a mistake in the author's own field) is called "the most famous of modern Swedes" (p. 115).

The book is illustrated by some very meek little pencil drawings in which the artist has been more anxious to produce a tidy sketch than to allow himself to be carried away by the strength of, say, the Vadstena Castle or the Exchange building in Copenhagen. M. A. S.

NEDRE LULEDALENS BYAR: en kulturgeografisk studie. By GERD ENEQUIST. (Geographica. Skr. Upsala Univ. Geogr. Inst. Nr. 4.) *Uppsala: Appelberg*, 1937. $10\frac{1}{2} \times 7\frac{1}{2}$ *inches;* xxxvi + 468 *pages; illustrations and maps*

This detailed and methodical study of the settlements in the three parishes (Edefors, Överluleå, Nederluleå) in the lower part of the Luleälv valley in Norrland is one of a series of monographs which have appeared since 1929 from the Geographical Institute at Uppsala University. It is essentially a study in historical geography, with the primary aim of interpreting the development of the present-day villages, with their characteristic "dispersed agglomerations." The author has a wealth of valuable historical data on which he has based his work, and the extent to which this can be utilized for comparisons of the economic geography between one period and another is one of the chief interests to the foreign reader. Not only can statistics be quoted from the middle of the sixteenth century, but in many cases surprisingly detailed cadastral maps from the seventeenth century illustrate the lay-out of the villages. The relationship can thus be discussed not only with the direct physical controls which do not change from century to century, but also with the changing economic environment of the Norrland settlements.

The book is divided into nine chapters, six of which describe the villages at approximately 1500, 1640, 1700, 1825, 1850, and at the present day. Chapter 1 is a concise account of the fundamental features of the physical background, and in the remaining parts of this study the interpretation makes use of the modern geomorphological description and terminology which are here explained. Chapters 5 and 7 are concerned with the effects upon the villages of the various acts of land redistribution, which, especially around 1700 and again in 1820, have so fundamentally altered the lay-out of villages over most of Sweden. Most important of these was probably *Laga Skiftet*, which was, between 1820 and 1850, largely responsible for the disappearance of the old Swedish village from most parts of the country. In the Luleå region of Norrland, owing to the small amount of land upon which settlement and cultivation is feasible, the effect was different, and villages there have preserved their old-time plan far more than in most of southern Sweden.

Space permits the mention of but one of the many points of interest to the foreign reader which can be found in this well-illustrated book. There is a

considerable development of the châlets, used not only for summer pasturage and fishing, but also, in "church villages," as temporary dwellings for parishioners from outlying parts to live in on the occasion of religious festivals. The "Kirk-town" of Gammelstad-Gäddvik illustrates this feature particularly well, and the preservation of these features to the present day is shown by the plan and the air photograph which are reproduced. F. H. W. G.

FINLAND. By J. HAMPDEN JACKSON. *London: George Allen and Unwin*, 1938. 9×5½ *inches; 244 pages; sketch-maps and diagrams.* 8*s* 6*d*

A good historical survey of Finland in English has been long overdue. Mr. Hampden Jackson brings a trained mind to bear on the subject, and his book is one which no student of the country can afford to miss. The history of the centuries under Swedish and Russian dominion is common knowledge; that of the brief but brutal civil "War of Independence" which cost the small country 24,000 lives, and of the industrial revolution, remained to be told. The author has done it graphically, illuminating many things, including subsequent economic adjustments and that curious episode when Svinhufvud nearly made Finland a German dependency by inviting Kaiser William II to send one of his sons as king.

The rapidity with which the country reconstructed her liberal and democratic constitution and institutions, with a remarkable gift for compromise, is shown in the survey of the cooperative movements, of the *Lex Kallio*, and the Åland Island problems. Finland, which has maintained, as probably no other country, the balance between classes, races, sexes, and the rural and urban workers, is always of interest. A country with so high a level of culture, by whatever standard culture is measured, which within two decades has survived a Communist insurrection and a Fascist *putsch* to emerge as an independent democratic republic, is of particular significance. Mr. Hampden Jackson is to be congratulated on the timely appearance of so balanced a work. K. G.

ANCIENS PLANS DE GENÈVE, XV^{e}–XVIII^{e} SIÈCLES. By ÉTIENNE CLOUZOT. (Mém. et Doc. Soc. Hist. et Archéol. Genève. Sér. in–4°. Tome VI.) *Genève: A. Jullien*, 1938. 12×9½ *inches; 150 pages; facsimile plans. Fr.s.*10

This volume consists of descriptive notes on 144 maps of Geneva which range in date from 1429 to 1838. Not all the maps are illustrated, but the sixteen plates and twenty-one figures are quite sufficiently explanatory, as many of the maps listed are obviously mere copies. The author admits that his collection is incomplete, and believes that other maps of Geneva exist in foreign libraries. It is very noticeable that, up to the middle of the eighteenth century, the maps are mainly concerned with fortifications and pay little attention to the town itself. One of the maps, of which an illustration is given, was made by a spy on behalf of the King of Sardinia in 1687, and was intended to show the terrain round Geneva, with special reference to the possibility of siege and attack. Several maps by English cartographers are included in the list. For instance a map of Geneva made by Bernard White to illustrate a 'History of Geneva' was printed in 1687; another is Emanuel Bowen's plan in his 'Complete system of geography,' published in 1747; while a third was made by I. Andrews in 1800. The most important English maps are those made by John Rocque in 1736 and in 1760. Little is known of this cartographer, who drew such excellent maps of London and other towns. This book gives some useful information about Rocque, and mentions the tradition that he was born at Geneva. The collection of notes and maps as a whole serves a most useful purpose, and it is a pity that similar lists do not exist for many English towns. E. W. G.

DIE TOSCANA: Landschaft, Kunst und Leben im Bild. By ARNOLD VON BORSIG, with an introduction by RANUCCIO BIANCHI-BANDINELLI. *Wien: Anton Schroll*, 1939. 12½×9 *inches;* 54+224 (*plates*) *pages; map. RM.*18

The factors which made for the rich variety of provincial life in Italy are ceasing rapidly to have effect, and the authors of this book had this in mind when they sought to produce, in the form of a volume of photographs, a study of historical value of the province that is "das Herzland Italiens," the cradle of a Humanism which still commands respect. Both text and plates carefully eschew the romantic. The brief Introduction shows an understanding of the tolerant, matter-of-fact, and impoverished Tuscan peasant, by nature neither soldier nor factory slave. The silver-grey Tuscan landscape, lacking sharp contrast in form or colour, makes heavy demands primarily on the skill of the photographer; the method of reproduction is less important, simple black-and-white half-tones preserving the essential detail. Centring on Florence and Siena, the plates cover most aspects of Tuscan life: landscapes, people, painting, sculpture, and buildings. Nearly all are described in detail in a series of paragraphs, following the Introduction, which contain much interesting information on such matters as the development of the Italian garden, methods of pruning olive trees, and the style of domestic architecture in regions stretching from the Maremma to the borders of Romagna. J. P. H. M.

HISTORY OF SPANISH ARCHITECTURE. By BERNARD BEVAN. *London: B. T. Batsford*, 1938. 9½×6 *inches;* xvi+200 *pages; illustrations, sketch-maps, and plans.* 21*s*

There are many excellent studies, limited in scope but exhaustive and intended for the specialist, of individual buildings and aspects of Spanish architecture. Less however is known about the architecture of Spain as a whole than about that of France or Italy, and hence the lack of a general survey. In a "condensed evolutionary study," designed to make good this defect, Mr. Bevan has concentrated on lesser-known buildings which are important for the developments they present, and has to some extent left aside those which are traditionally famous. Thus Visigothic churches (such as S. Juan de Baños and S. Pedro de la Nave), where there are horseshoe arches dating from before the Muhammadan Conquest, receive welcome attention, as do the Mudéjar belfries of Aragon, and Catalan Gothic. The chapters are planned on a regional basis: the only satisfactory way of describing architectural developments in a country in which two civilizations so different as the Christian and the Muhammadan flourished contemporaneously. Whereas the Muhammadan had finally little that was structural to contribute, Spain from the point of view of the principles of Christian architecture was for long a marginal land: its Romanesque and Gothic buildings could rarely compare with those of France and Italy. Later, with the development of Baroque, it came into its own, and in its turn influenced the New World, as Mr. Bevan shows. Mr. Bevan deals briefly with castles and palaces; more information about domestic architecture would be welcome. Subsequent editions of the book might be extended in scope to include chapters on architecture in Portugal. The text is well equipped with plans and well indexed; and there are a large number of excellent plates. J. P. H. M.

SCARRED BACKGROUND: a journey through Albania. By NIGEL HESELTINE. *London: Lovat Dickson*, 1938. 8½×5½ *inches;* 234 pages*; illustrations and route-map.* 10*s* 6*d*

The photographs illustrating this book are pleasant. Well composed, they have atmosphere and do not strain after effect. Unfortunately the majority appear

on the jacket, and so are doomed to speedy destruction. The line-drawings by Mr. A. Hope Reford, clever and original enough, could be spared; with their snub noses, beery leers, and prancing legs they befit a work on medieval English grotesques rather than a description of the serious, dignified Albanians. Mr. Heseltine writes so neatly and clearly that till one tires of the personal note his prose is a pleasure to read. He traversed on foot or lorry several border regions of the Albanian rectangle, and so saw some fine mountain scenery and a little of the life of Albanian shepherds. In an interval at Korrchë he notes with approval the statue of the Unknown Warrior; in another at Tiranë he regrets the Albanian adoption of shoddy Western ways; and in the northern mountains he pauses to discourse on the heroic songs which are still the staple entertainment of Albanian mountaineers. There is much in the book that is truly observed and said. But the truth is so larded with inaccuracies, such as the statement that the Italians built the road from Tiranë to Shkodër, and with inadequacies, such as not recognizing the foreign origin of the mother of the young Bey of Libohovë, that the book is scarcely for those who would learn about Albania. M. M. H.

ASIA

TRANSJORDANIEN: vorgeschichtliche Forschungen. By HANS RHOTERT and others. (Verlauf und Ergebnisse der XII. Deutschen Inner-Afrikanischen Forschungs-Expedition 1934–35 . . . Edited by AD. E. JENSEN and H. RHOTERT.) *Stuttgart: Strecker und Schröder*, 1938. 12×8½ *inches;* xii+252 *pages; illustrations and maps. M.*15

This volume is one of a series of archaeological studies in out-of-the-way parts of the world due to the energy of the late Leo Frobenius, to whom it is dedicated. It describes an expedition to the region of Kilwa, which lies to the south-east of Maan in Transjordania. There fairly recent buildings, surface stone industries, and rock-drawings were examined. Many of the latter were already known, and had been published by Dr. Horsfield in the American *Journal of Archaeology* (vol. 37, 1933). Indeed, a hasty glance might suggest that the work of the German expedition was to some extent redundant. The surface finds of stone implements seem to be more or less the same over large areas of the east Jordan desert and neighbouring lands, and the immense collections made by Dr. Henry Field and subsequently studied by Miss Dorothy Garrod (whose findings, though known to some of us, have not yet actually been published) appear very similar to those discovered in the Kilwa district. As is the case with all surface finds, to make any accurate dating or cultural connections is both difficult and dangerous. Typologically speaking the products of Lower Palaeolithic cultures are present, as are also those of Upper Palaeolithic man, but the main mass of finds may, as suggested here, belong to some desert culture of which we have very little knowledge at present. Every scrap of information, then, that can be collected about these desert stone industries is important, and the matter contained in the present publication should not be neglected. The text is perhaps rather too drawn out. The author has tended too much simply to transcribe his day-to-day diary in an attempt to take his readers with him once again on the expedition. To many this may be a pleasant relaxation: the student would have preferred something crisper, with the irrelevant detail omitted. The volume however deserves careful consideration since it combines in one work information which can be only partly obtained elsewhere, and the publishers have found space for a large number of very useful illustrations. M. C. B.

INDIAN ARTIFEX. By VICTOR BAYLEY. *London: Robert Hale*, 1939. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* 288 *pages; illustrations (by P. Youngman Carter).* 12*s* 6*d*

This is a collection of incidents in the life of a railway construction engineer in India and Mesopotamia, with a final chapter giving the author's reflections on some aspects of what he terms the mechanization of the world, and his speculations on speed in the transportation problems of the immediate future. The first eight chapters are the most interesting, and they contain good descriptions of daily incidents of life among the Rajputs, and of some of the characteristics of the Rajput people. The author's kindly and appreciative references to the qualities of his Indian coolie labour are well deserved, as any engineer who has had the privilege of working with these people, and succeeded in gaining their confidence and respect, can testify. The lives of the coolies are hard and untouched by much in the way of brightness, and the author's tea-party, given at the successful conclusion of a hard construction job, no doubt brought to them a measure of joy out of all proportion to the cost involved.

The chapters dealing with the author's work in Mesopotamia are not the equal of the others either in literary style or in interest; this is perhaps to be expected, since his most impressionable years were spent in Rajputana.

F. F. F.

A CALENDAR OF THE COURT MINUTES, ETC., OF THE EAST India Company, 1677–79. By ETHEL SAINSBURY; with an introduction and notes by W. T. OTTEWILL. *Oxford: Clarendon Press*, 1938. 9×6 *inches;* xxx+376 *pages.* 21*s*

The Court Minutes of the East India Company from the grant of its charter in 1600 down to the end of 1634 were calendared by the late Mr. Noel Sainsbury in his 'Calendars of State Papers, East Indies,' the last instalment of which was published by the Public Record Office in 1892. Thereafter the Record Department of the India Office, to which the records had been transferred, undertook the work of calendaring from 1635 onwards in the present series. The latter department has the advantage of holding many other documents bearing upon the subjects referred to in the Court Minutes; these have also been examined now, and quoted where necessary. These calendars are not only of the greatest value to students of Indian history, obviating the labour of reading through masses of material, but also form a permanent and handy record of events in case of the loss or destruction of the original records. An important feature of them is that all names are carefully printed, and the detail of the contents given will make it unnecessary for the reader, save in rare instances, to refer to the original papers.

Each volume covers a period of years varying with the amount and character of the records. During the period (1677–79) covered by the present volume no events of outstanding importance occurred. Owing to the war between France and Holland and certain disputes with the Portuguese there was constant anxiety about the safety of the Company's ships. The Court's deliberations were otherwise directed to familiar matters, such as requests for loans from the king, breaches of rules by its servants, and measures for extending and improving its trade, including attempts, as yet unsuccessful, to open traffic with Japan. The difficulty of navigating the Hooghly river was already being felt, and attractive rewards were offered to the commanders and staffs of vessels that managed to sail up to Hooghly, with instructions to acquire information of the shoals, channels, and tides: dangers that led to the establishment later of the famous Hooghly Pilot Service.

This is the eleventh volume of the series compiled by Miss Sainsbury, who

terminated forty-five years' connection with the department in 1937, and a word of warm praise must be added for the scrupulous care with which she performed her laborious but useful task. The full indexes will be specially appreciated by students. C. E. A. W. O.

THE BRITISH IN INDIA. By E. N. DAWSON. (Colonial Adventure and Achievement.) *London: Sir Isaac Pitman and Sons*, [1938]. 7½×5 *inches;* xiv+106 *pages; illustrations and maps.* 1*s* 10*d*

This little volume of Pitman's Colonial Adventure and Achievement Series gives a short, and necessarily much condensed, summary of the English connection with India from the close of the sixteenth century down to modern times. It has been compiled in a readable style and, with the exception of some minor errors in dates and other respects, it is generally accurate.

C. E. A. W. O.

WISSENSCHAFTLICHE ERGEBNISSE DER NIEDERLÄNDISCHEN Expeditionen in den Karakorum und die angrenzenden Gebiete in den Jahren 1922, 1925, 1929/30 und 1935. Edited by C. VISSER and JENNY VISSER-HOOFT. Band II. *Leiden: E. J. Brill*, 1938. 11×7 *inches;* viii+216 *pages; illustrations and maps.* 12 *guilders*

This book is the second volume of a series devoted to the scientific results of four expeditions made by Dr. Ph. C. Visser and Frau Jenny Visser-Hooft in the Karakoram and neighbouring regions between the years 1922 and 1935. Volume I appeared in 1935 and contains chapters on geography by Dr. Visser, ethnography by Frau Visser-Hooft, and zoology edited by Professor J. B. Corporal. Volume II, the subject of this review, has been written by Dr. Visser and is devoted entirely to glaciology. Botany, geology, meteorology, and physiology remain yet to be described.

Dr. and Frau Visser, with the assistance of Afraz Ghul Khan and Muhammad Akram, both from the Survey of India, have mapped extensive areas in the Karakoram and Aghil regions which were previously almost entirely unexplored. In the Karakoram ten glaciers of over 20 kilometres in length have been for the first time accurately surveyed; some indeed were new to geography. Those acquainted with these inhospitable regions, with obstacles such as ice-pyramids and séracs, rivers liable to rapid and dangerous flooding, and vertical cliffs of gravel, will appreciate the difficulties under which the Vissers worked, difficulties which are only implicit in these scientific accounts.

The majority of glaciers in this region are classified by Visser in his Firnkessel type (see Table III), a new name given to the Muztagh type of Oestreich. This type is characterized by the absence of névé fields (p. 49). The glaciers lie in long valleys of uniform width and are nourished almost entirely by snow avalanches. Examples are given by the Batura, Hispar, Pasu, and Baltoro glaciers. The Biafo and Rimo glaciers are regarded as representatives of the Alpine type of glacier (" Firnmulden-Vergletscherungstyp " of Visser), in which each glacier is considered to be nourished from its own névé field. The Siachen is classified in both groups, while the Baltoro glacier, in spite of possessing a large névé field in the neighbourhood of the Golden Throne, is evidently considered to be fed principally by avalanches. These Firnkessel glaciers do not appear to differ significantly from the Avalanche or Turkistan type of von Klebelsberg, which Visser regards as a distinct type but yet maintains not to be present in the Karakoram. If the Firnkessel type is accepted as a distinct group, it would probably be advisable to consider it as transitional in nature between the glaciers of the Alps and Turkistan, a group in which the Biafo and Rimo glaciers

would also be placed, as well as the Diamir and Rakhiot glaciers of Nanga Parbat (Finsterwalder, *Zeitschr. f. Gletscherkunde* 25 (1937) 69). The manner of nourishment of these glaciers is indeed somewhat conjectural, because little is known of these regions during the winter months.

The Firnkessel type is compared by Visser (p. 50) with the sub-polar glaciers of Ahlmann, though it seems very improbable that the climatic conditions of the sub-polar regions and the Karakoram are similar, and that summer melting of the sub-polar glaciers is ever as pronounced as that of the glaciers in the Karakoram. The name Firnkessel lays emphasis on the importance of firn ice, but it has yet to be established that much of the white ice of these Karakoram glaciers, at least in their middle and lower reaches, is in reality true firn. Firn has a specific gravity ranging from about 0·35 to 0·65 and possesses interconnected air spaces (*Geogr. J.* 92 (1938) 221). Visser states (p. 56) that the firn ice grows to crystals the size of walnuts, while the grain structure of the glacier ice underlying the white and supposedly firn ice is indeterminable. Recrystallization of firn to yield crystals as large as walnuts would probably cause the elimination of many of the air spaces and would presumably raise the specific gravity of the ice above 0·65. It is clear that there is a distinction between the white and the dark ice of these Karakoram glaciers, but it is perhaps unwise to assume without definite physical tests that the white ice is everywhere firn.

Visser compares the ablation of the Rimo glacier with that of the Aletsch, and comes to the surprising conclusion that the Rimo glacier gives rise per square kilometre of surface to less than half the volume of water delivered by the Aletsch (p. 33). But according to his figures the volume of melt-water given off by the Rimo (1860 cubic metres per square kilometre per day) is about one-quarter of the calculated surface ablation for the same glacier, which is 7700 cubic metres per square kilometre per day. Both calculations are based on the volume of water in the Shyok lake: the former on the basis of two and a half years being required to fill the lake of 1475 million cubic metres; the latter on the basis of the daily rise of the lake of 20 centimetres, which was observed by Gunn.

Chapter 10 introduces Visser's observations on the superposition of glaciers. Washburn has proposed the term "superimposed glacier" for such a glacier carried upon the back of another (*Geogr. J.* 87 (1936) 490). His view is that in Alaska superimposed glaciers are less common than glaciers compressed into adjacent units sharing the same valley floor, and only occur where a tributary glacier is discharged from a hanging valley into a deeper trunk valley. Visser, on the other hand, considers superimposed glaciers to be prevalent, believing that the confluence of glaciers in two valleys at the same level (*Gleichsohligkeit*) is exceptional (p. 85). This appears to be an overstatement, since observations in regions that were formerly glaciated would suggest the prevalence of the larger confluent valleys at the same level. Moreover, zones of vertical ice are frequently found running down the centres of Karakoram glaciers (the Biafo is an example known to the reviewer), which would find a readier explanation on the classic theory of Agassiz than by postulating superposition. Nevertheless the emphasis laid by Visser on superposition is valuable, and it is largely through his explorations that this type of union has been in some instances so convincingly demonstrated.

The problem of the ice-pyramids so generally found north of the Karakoram watershed is fully discussed in Chapter 9. Visser's conclusions are that the pyramids consist of a carapace of firn ice floating on and drawn out by faster-moving glacier ice (pp. 63, 64). Elsewhere however it is stated that the firn

carapace moves with a greater velocity than the underlying glacier ice (pp. 53, 201), and it may be questioned if the postulated differential velocities are necessarily of significance in the formation of pyramids. The most striking feature of these pyramid glaciers is that they occur almost invariably on the north side of the Indo-Chinese watershed, from which it may be supposed that climatic factors are the most important in their formation. Climatic factors are recognized by the author as playing an important rôle (p. 59), but are considered as of less importance than the existence of rootless firn ice carried on the back of glacier ice. It is difficult to see why superimposed glaciers should be less common on the south side of the watershed than on the north side, but it is reasonable to suppose that the watershed is a boundary between climatic regions. The significance of climate, even of seasonal changes, is illustrated by observations made on the Pasu glacier. In the spring of 1925 this glacier was a chaos of almost impassable towers and séracs, but by the middle of September it had become almost smooth (p. 74). The origin of these pyramids is still in fact a mystery, which will not be cleared up until observations are made on both sides of the watershed throughout the year.

A long chapter is devoted to the nature of glacier movement, and the followers of Tyndall and Forbes are ranged against each other, each armed with definitions of plasticity and rigidity. Visser is opposed to the drawing of geological analogies, criticizing Cloos for comparing the movement of ice with that of crustal blocks, plutonic magma, and viscous lava-flows (p. 113). Some of the examples chosen by Cloos are perhaps unfortunate, for it is more likely that the movement of glaciers is comparable with that of rocks undergoing the processes of metamorphism, in which recrystallization of material takes place in a medium that is for the most part solid and not fluid. To consider glacial movement however as a problem by itself, devoid of geological analogies, is unsound. The extent to which the sciences of seismology, geology, and glaciology are all concerned with the problem of plasticity and rigidity is indeed surprising. In a book devoted primarily to metals Beilby also discussed the flow of ice under stress ('Aggregation and flow of solids,' 1921, p. 199), and realized that the peculiar behaviour of ice, at least in temperate latitudes, is due to its existence above its crystallization temperature (−12° C.) and only just below its melting-point, at a temperature at which the molecules are highly energized. The physical condition of ice has been ably discussed in a paper by Bradford Washburn (*Geogr. J.* 87 (1936) 493), which is not mentioned by the author.

A long chapter is devoted to fluctuations in the positions of the glacier snouts. This appears to have been based to a very large extent on a paper by Mason published in 1930 (*Rec. Geol. Surv. Ind.* 63 (1930) 214–78). The paper is quoted in the bibliographical index, but scant acknowledgment is given to it in the text.

This volume contains the maps, printed by the Survey of India, of the area surveyed by Dr. and Frau Visser during their travels. Such maps have not hitherto been available to illustrate their descriptions. The Upper Shaksgam survey of 1935 is not however included, and has not yet been published in any form.

In conclusion, this volume is a most valuable contribution to glaciology, and explorers are indebted to Dr. Visser for this detailed exposition of his observations and views. The work will remain a standard of reference and will encourage others who come to these regions to study the glaciers with the same enthusiasm as has been shown by Dr. Visser himself. J. B. A.

SALWEEN. By RONALD KAULBACK. *London: Hodder and Stoughton*, 1938. 9×5½ *inches;* xii+332 *pages; illustrations and maps.* 15*s*

Eastern Tibet, the marches of Poyü, Zayul, and Kam, land of deep erosions, where the great rivers of south-eastern Asia have carved colossal canyons through the highlands of Tibet, was until recent years one of the least-known portions of the world. To-day most of its secrets have been yielded up, thanks to a band of enterprising travellers, amongst whom the author can now claim distinguished rank. Mr. Kaulback had already visited this hidden corner of Tibet in company with Mr. Kingdon Ward in 1933. 'Salween' is the record of his later, more extensive, and more interesting journey, made with the object of exploring the basin of the upper Salween and of penetrating, if it were possible, into the hinterland where its unknown sources lie.

The party, consisting of Mr. Kaulback and Mr. Hanbury-Tracy, and their native followers, entered Tibet from Upper Burma in the early summer of 1935, and made their way through Rima to Sangachö Dzong (visited by Kingdon Ward and Bailey) on the upper Zayul Chu. Thence they worked north-west and north, down the Ngagong and up the Potö Chu, tributaries of the Tsangpo, and reached eventually Shopando (visited by Pereira and A. K.), on the *Gya Lam*, the great "China Road," which leads from Lhasa to Chamdo, Batang, and Peiping. On this section of the journey they separated for a time, the better to explore the Ngagong valley and the Tsangpo–Ngagong watershed. Kaulback himself made a diversion into hidden Pemakö, a low-lying corner of Tibet, a region of forests and jungles on the borders of Assam.

From Shopando they pushed on towards their goal, the upper Salween; and so, travelling through country mainly unexplored, they came to Nakshö Biru, on the northern China Road, leading from Lhasa to Jeykundo, where the Panchen Lama was then in residence. In this neighbourhood they linked their routes with those of Rockhill, Bower, and Bonvalet. At Nakshö Biru, reached in mid-winter, the two travellers had left behind the land of deep erosions, reaching the edge of the *Chang Tang*, the bleak plateau country of Tibet; and here they stood upon the threshold of their great adventure, the exploration of the unknown Nak Chu, the Black river, as the Tibetans term the upper Salween in these parts. But unfortunately (or perhaps fortunately, considering the weakness of their unarmed party and the prevalence of nomad brigands on the uplands of Tibet) the authorities of Nakshö Biru refused them transport for their journey farther north.

After being detained for three weary months at Nakshö Biru they reluctantly gave up their plan of following the Salween to its source. Back at Shopando they sought to follow the China Road eastwards to Shabye Zamka, where it traverses the Salween by a bridge. But at Lho Dzong they were again held up. Working their way south along the basin of the Salween, the banks of which they touched at various points, they came to Tentok Gamba, lying beyond the Salween on a tributary of the Mekong, the next of the great parallel rivers to the east. (Teichman had been the first to come this way, travelling from Chamdo by the Yunnan road through Tsawarong.) From Tentok Gomba Kaulback planned to explore the unknown Bashö country farther north, southwards of Chamdo. But for the third time the party was held up by the authorities on the Tibetan–Chinese frontier, which they had now approached. Actually Tibetan troops were then engaged somewhere near Chamdo in one of the obscure frontier wars which plague this borderland. Again they turned back south and west, and emerged eventually by the Lohit river at Sadiya in Assam, after spending eighteen months and travelling 3000 miles across the unknown hinterlands of east Tibet. Though they failed to trace the sources of the Salween,

they had located it at many unknown points and covered with their route-maps large areas never visited by foreign travellers before.

Kaulback's story is thus the record of a fine piece of exploration work, which must have called for courage and endurance to a high degree. Like most successful travellers they lived off native food supplies, the grain, buttered tea, mutton and yak meat, and the ubiquitous turnip of the uplands of Tibet. The descriptions bring vividly before the reader the background of the countryside; but only those who know this wild, remote, but fascinating region can appreciate the hardships and discomforts of a year spent on the road in east Tibet.

There is a good index, and the photographic illustrations and the map are excellent, though on the latter routes and frontiers might with advantage have been more clearly shown.

The story of the journey told by Mr. Hanbury-Tracy, under the title 'Black river of Tibet,' was reviewed in the *Journal* for December 1938. E. T.

LORDS OF THE SUNSET: a tour in the Shan States. By MAURICE COLLIS. *London: Faber and Faber*, 1938. 9×5½ *inches;* 326 *pages; illustrations and map.* 15*s*

The Lords of the Sunset are the chieftains of the Shan States in Burma. It is a charming and unspoilt country which presents a rich but comparatively unexplored field. The climate is cool and healthy, and the landscape and the people alike are a delight to the eyes. The Shans have been sixty years under a settled British administration, yet little has been done either by artist, naturalist, or anthropologist. The only works written since the country came under our rule are Mrs. Leslie Milne's 'Shans at home' (London, 1910), Cochrane's 'Shans' (Rangoon, 1915), and Lady Scott's 'Scott of the Shan Hills' (London, 1936).

The author is a retired member of the Indian Civil Service in Burma, and although he had not served among the Shans he was in touch with officials there who gave him facilities during the tour he describes. He did not leave the beaten track, but even so he found ample material for an attractively written travel book and he collected quite a number of good photographs.

HONG KONG. By ELLEN THORBECKE. *Hong Kong: Kelly and Walsh*, [1938]. 9×7 *inches;* 69 *pages; illustrations and sketch-maps*

This is an attractive volume, with alternate pages of print and well-selected plates, set off by coloured sketches. It succeeds in conveying the right atmosphere, and there is much information about the colony and the manifold features of Chinese life and character: business, pleasure, and even religion. It is curious how few writers on China indicate the connection between Taoist philosophy and its popular manifestations at the hands of temple-priests and fortune-tellers. For those who know the "Isle of fragrance" this little book will revive many a delightful memory. Others may learn much from it of the results of the mingling of East and West in a far corner of the Empire. Incidentally it suggests that social relations between British and educated Chinese are better than they used to be. The publishers are to be congratulated on a beautiful production. A. S. E.-S.

AFRICA

BLACK BARBARY. By PATRICK TURNBULL. *London: Hurst and Blackett*, (1938). 9×5½ *inches;* 288 (*incl.* x) *pages; illustrations and sketch-map.* 15*s*

Readers of this book will do well to be neither misled nor put off by the pseudo-scholarship of much of the introductory chapter on the Berbers nor by the rather pathetic end-paper sketch-map, which is inadequate for the intelligent

following of the text. But these things said, one can well recommend this book, not only as the first literary traveller's account in English of the large area of south and south-east Morocco which has only recently been pacified, but also for its readable style and its generally accurate and often felicitous descriptive accounts. The author, in search of "copy" and essentially a modern traveller, went by car as unaccompanied owner-driver along the new roads and improved tracks of the High Atlas, Sous, Anti-Atlas, and Jebel Sarro region, to the south and south-east of Marraksh, and of the Middle Atlas region to the south-east of Meknes, spending several months in these parts by special permission of the French military authorities. He has described the scenery, narrated the more interesting incidents of his wanderings, and given thoughtful impressions of people he saw and met. His accounts of the Foreign Legion and its work, and of some outstanding personalities of the French military conquest, reveal the methods and bravery of both, while accounts of the opposing native personalities equally reveal the pluck and hardiness of the Atlas Berbers. Many interesting items of native folk-lore are given, and there are accounts of picturesque scenes in which the tribesmen figure. But, although not unsympathetic to the natives, this book is written in the main from the point of view of the European in control. It is illustrated with a considerable number of excellent photographs, many of which will reveal, for the first time probably to many readers in English, the strange beauty of the native architecture of southern Morocco. There are very few misprints, but the reference on p. 190 to one mountainous area crossed by the author as being formed of "precambrian larvae" deserves mention. The book has no index. W. Fg.

CONTRIBUTIONS A L'ÉTUDE DU SAHARA OCCIDENTAL. Edited by THÉODORE MONOD. Fascicule I. Gravures, peintures et inscriptions rupestres. By THÉODORE MONOD. (Publns. Com. Études Hist. et Scient. Afrique Occidentale Française. Sér A. No. 7.) *Paris: Larose*, 1938. 10×6½ *inches;* 156+viii *pages; illustrations and sketch-map*

This is the seventh in a series of anthropological works which are designed to give first-hand information. There is also another parallel series which deals with the geological, zoological, and botanical data. The volume under review is in the nature of a catalogue and, once the necessarily elaborate abbreviations have been learnt, is easy to use. There is a map at the beginning which shows exactly the area covered and where the various sites mentioned occur. These are then described in alphabetical order, abbreviations being used to indicate whether engravings, paintings, or inscriptions occur and whether these are prehistoric (Neolithic), ancient (Libyco-berber), or recent (Muhammadan). Indications as to the techniques employed are also given, as well as illustrations of drawings from the more important sites and individual references to the many figures, the latter in a list at the end of the volume. The whole forms a very painstaking piece of work and a mine of accurate information. The different ages are largely determined by considering the fauna figured. To-day the area is too dry for extensive agriculture or the herding of animals to be possible. The depicting then of domestic animals such as the ox indicates that at one time different climatic conditions obtained; and this it is suggested must have been in Neolithic times. The majority of the animals figured however are horses and camels, sometimes being ridden; they could belong either to the second or to the recent series, but careful study on the spot makes differentiation not impossible. Rightly M. Monod uses "the study of the state of preservation of the figures" with great reserve; though sometimes useful it is always a dangerous method of study. Naturally the inscriptions are full of interest, and

much new material is made available. Altogether this little volume is a useful publication, and students should not forget its existence just because the western Sahara seems far away from the cultural centres of the world in ancient times.

M. C. B.

AFRICAN WOMEN: a study of the Ibo of Nigeria. By SYLVIA LEITH-ROSS. *London: Faber and Faber*, 1939. 9×5½ *inches;* 368 *pages; illustrations and maps.* 15*s*

The authoress did not attempt to learn a native language and delve into the Ibos' inmost thoughts in the course of a few months; she relied on interpreters and on her considerable experience of Nigeria before she was awarded a Leverhulme Research Fellowship and devoted two years to a study of the Ibo women, more especially of Owerri province. The Ibo are some four millions strong, and therefore the largest negro tribe in the world; they are also one of the most intelligent and finest physically, and, in the opinion of Mrs. Leith-Ross, the most "go-ahead," though probably some of the Yoruba might question this, especially in the way of culture and art. One might also demur to the statement that their intelligence is potentially equal to that of the average European; it is true that their cranial capacity reaches some 1460 c.c., *i.e.* practically the European level, but anatomists seem to think that the negro cortex is smaller, and of course there is considerable doubt as to the real correspondence between brain size and intelligence.

The keynote of the book is sounded early in the phrase "the women, economically and politically, are at least the equal of the men." The authoress then discusses the Aba riots of 1929, which so signally illustrated their initiative, organizing ability, and solidarity. The Ibos' intense desire of, and love for, children are well brought out, as also their inborn democratic spirit. The greater part of the book is taken up with an extremely interesting and complete review of woman's life from birth to death, and beyond, though the religious aspect is not treated so fully as are the social and economic. The problems and difficulties of the Christian (or semi-Christian) and of the more advanced youth, as well as of the missionary, educationalist, and administrator who try to solve them, are sensibly and wisely discussed, and illustrated by some amusing stories. Among books treating more particularly of the women, this stands pre-eminent, and should be in the hands of all who would like to know how this very likeable nation is facing modern conditions, and who wish to help and guide it.

P. A. T.

THE SOUTH AND EAST AFRICAN YEAR BOOK AND GUIDE. Edited by G. GORDON BROWN (for The Union-Castle Mail Steamship Company). Forty-fifth Edition, 1939. *London: Sampson Low, Marston and Co.*, 1938. 7½×5 *inches;* lxxvi+1168+64 (*maps*) *pages; maps and plans.* 2*s* 6*d* (3*s post free in U.K.*, 3*s* 3*d elsewhere*)

About one-third of the 1939 edition of the Year Book describes the means of reaching South and East Africa, and land routes for travel therein, providing information of the type to be found in standard guide books. The bulk of its pages however are devoted to general information and statistics which seem to cover practically every aspect of life: history, military campaigns, government, finance, trade, mining and agriculture, the native problems, health and sickness. It is possible to discover from these pages the legal wages for paperhangers in Port Elizabeth and Pretoria, or the methods recommended for treating snake-bite. There is a very full index, and sixty-four pages of maps by Bartholomew.

THE SHERBRO OF SIERRA LEONE: a preliminary report on the work of the University Museum's expedition to West Africa, 1937. By H. U. HALL. *Philadelphia: The University Press, University of Pennsylvania* [*London: Oxford University Press*], 1938. 10½×8 *inches;* vi+52 *pages (incl.* 16 *pages of plates); illustrations and map.* 9*s*

This publication of the University Museum of Pennsylvania is a preliminary report of the work of its expedition to West Africa in 1937, and whilst there is a great deal of interesting matter in this short ethnological account of the Sherbro in Sierra Leone, we shall await the full report with considerable interest to see what Mr. Hall has to tell us further about these people.

Some of the illustrations are good; the others are not specially interesting or well taken in themselves. E. B. H.

NORTH AMERICA

THE HARGRAVE CORRESPONDENCE, 1821–1843. Edited by G. P. DE T. GLAZEBROOK. (The Publications of the Champlain Society. XXIV.) *Toronto,* 1938. 10×6½ *inches;* xxvi+472 *pages; illustration and map*

This is a selection of one hundred and seventy-six letters from the Hargrave collection. Hargrave himself during most of the period was stationed at York Factory, the "capital" of the vast territories of the Hudson's Bay Company both before and after the amalgamation with the North West Company, and from this strategic centre he kept in touch with officers of the Company scattered in posts from the Saguenay to the Columbia and from the Great Lakes to the Arctic. These are personal letters, addressed to Hargrave, covering a multitude of topics from literature and English political gossip to the season's fur prospects, and betraying almost as wide a range of educational attainment among the writers. Business matters, naturally, are not entirely excluded, but the great value of the letters lies in the personal reactions of the writers. Hargrave was of course familiar with much of the country and with the kind of life that the Company's officers had to live. In writing to him there was no need of lengthy explanation, and most of the information on such topics as the nature of the country, the climate, the life at the posts, the Company's expansion westwards across the Rockies and northwards to the Arctic, the increasing contact and friction with encroaching settlers, and the development of agriculture on the Red River is given by brief comment or even indirect allusion. The series as a whole forms a splendid supplement to the official records of the Company. The editor's task has been admirably done: beyond choosing the letters to be included he has confined himself to a short but excellent introduction, and to footnotes identifying writers or posts. A clear black-and-white pocket-map (unfortunately however without a scale) shows the drainage of the area and locates the posts of the Company. R. O. B.

THE SOUTH: its economic-geographic development. By A. E. PARKINS. *New York: John Wiley and Sons—London: Chapman and Hall,* 1938. 9½×6 *inches;* x+528 *pages; illustrations and maps.* 25*s*

The part of the United States known as "the South" is a geographer's paradise. It can be readily demarcated in a variety of ways, and offers for study a wide range of problems. It allows the isolation of various environmental and human factors—climatic controls, soil types, geomorphic features, racial, historical, cultural, and economic elements—and the tracing of the influence of each on the life of the people. Hence there is no dearth of published material dealing with the South; the abridged bibliography in this book lists 126 references. One

may therefore well ask whether there is room for yet another volume and, if so, what the nature of its special contribution may be.

The author's avowed purpose is to present the evolution of southern civilization as the outcome of a series of historical events in a given regional setting, analysed in text-book manner and within the grasp of the university student or intelligent lay reader. The book brings together in well-organized form a vast amount of thoroughly digested information partly from first-hand knowledge extending over many years, partly from relatively inaccessible records, relating in turn to the natural setting and man's modification of it, the white man's invasion, the growth of highways, waterways, and railways, the development of agriculture and its present status, the resources of power, minerals, forests, and other raw materials and their part in industrial development, and finally the problems of urbanization.

While inclined to be optimistic about the prospects for industrial and urban growth, the author is clearly less hopeful about the future of agriculture. He believes that industry is being built on firmer foundations in the South than has been the case in New England: the essentials, raw materials, coal, oil, gas, and water-power, are present in quantity near at hand.

Apart from Federal work in soil conservation and harbour and waterway engineering, he is less sanguine about such government schemes for regional planning as the T.V.A. activities. A final chapter on "the Southern prospect" summarizes in an interesting way the author's conclusions, starting from the breaking down of sectional barriers, analysing the trend of population distribution, and forecasting the future development in manufacture and agriculture.

The book is unusual in restricting its illustrations to clearly labelled diagrams and outline maps, original well-cooked photographs of the author's own taking, and reproductions of old woodcuts and engravings from periodicals and books of three-quarters of a century ago. Such pictures as those showing "Loading an Alabama river steamer at night" (1842), "Emigrant wagons in a town in Mississippi" (1874), and Sir Charles Lyell's "Gully near Milledgeville, Georgia, 1846," are certainly worth salvaging from oblivion. G. B. B.

CENTRAL AND SOUTH AMERICA

GLORIES OF THE MAYA. By THOMAS GANN. *London: Duckworth*, 1938. 9 × 5½ *inches;* 280 (*incl.* xvi) *pages; illustrations and maps.* 18*s*

The late Dr. Gann possessed a ready pen, basing the publications issued regularly for several years upon diaries carefully kept during journeys in Central America. He had plenty of material; for, first as junior and afterwards senior Medical Officer in the colony of British Honduras, he found himself many years ago in a position singularly favourable for the development of a taste for antiquities. Many of the magnificent Maya ruins of Guatemala, the Republic of Honduras, and Yucatan had long been admired and recorded; but evidence of the genius of the Maya architects and sculptors in British Honduras, through which the great builders passed on their northward trek, had long sunk into oblivion.

Dr. Gann, whose duties took him into remote regions of the colony, heard (chiefly from mahogany cutters and gatherers of chicle) of stone temples buried in dense forest, of tombs and caches of pottery and ornaments; he visited a large number of these sites, and developed a collector's flair, especially for the jade or jadeite carvings which were valued so highly by the Maya themselves in their heyday. The British Museum has recently become the beneficiary of this collecting spirit, the whole of a remarkable series of jades, and of the "eccentric

flints" which still puzzle students of Maya art, having been bequeathed to it by Dr. Gann.

The new (posthumous) volume refers to a series of journeys in Maya country made at different times, some quite recently in the highlands of Guatemala; but perhaps the most interesting pages are those dealing with explorations in the region behind Corozal, where Gann had a house and coconut walk, and leisure for expeditions. No visitor to Central America should fail to take to heart the author's remarks on pp. 93–6 on the prevalent faking of antiquities.

Under the circumstances, a number of typographical errors in the text were perhaps inevitable, and a line near the foot of p. 223 should read "Katun of twenty years, the Tun or year, the Uinal or month, and the Kin or day . . ."

L. E. J.

AUSTRALASIA AND PACIFIC

CANOES OF OCEANIA. By A. C. HADDON and JAMES HORNELL. Volume III. Definition of terms, general survey and conclusions. By A. C. HADDON and JAMES HORNELL. (Bernice P. Bishop Museum. Special publication 29.) *Honolulu, Hawaii*, 1938. 11×7 *inches;* ii+88 *pages; illustrations and maps*

In completion of their laborious task the authors in this final volume (*Geogr. J.* 90 (1937) 478–9 and 92 (1938) 84) discuss a number of matters which would have obstructed the flow of the text in the first two volumes, together with some general questions and conclusions which emerge from the study of the data gathered from the whole of the Oceanic area.

The section dealing with definitions of terms is in the form of a glossary, and in view of its importance to the understanding of the technology of the earlier volumes, its appearance in the first of these would have been preferable.

In the "General survey" are discussed the wider significance of the structure and distribution of rafts, outrigger canoes and the various types of outrigger attachments, plank boats, double canoes, and masts and sails. Throughout this section are interspersed the authors' views as to the origin, development, and means of distribution of the types of vessels as a whole, and of structural details. They state that "It is impossible to discuss the origin and migrations of the various types of sea craft met with in Oceania and New Guinea without references to those of Indonesia, and to those of India, Madagascar, and East Africa."

The difficulty of reaching unqualified conclusions on problems of diffusion and migration in Oceania is emphasized in the section dealing with cultural spreads from Indonesia. Special attention is given to the views of Müller, Rivers, Friederici, and more briefly to those of Heine-Geldern, Churchill, Graebner, Smith, and Williamson. Friederici's treatment of the evidence afforded by canoe terms is summarized by the authors "without in any way committing" themselves. Throughout the whole work they have indeed shown an admirable reluctance to commit themselves on insufficient evidence. They begin their final section of conclusions by stating that they "can here attempt only a sketch on broad lines of what we consider may have happened" in the historical process of the peopling of Oceania. They point out that the Melanesians are fundamentally of Papuan stock, but variously mixed with immigrants from the East Indian Archipelago; that at least two ethnic groups can be distinguished in Indonesia, and that both Polynesians and Micronesians are of composite and related origin. It is doubtful whether Papuans reached Polynesia, but migrations from Indonesia from time to time spread into Melanesia, Micronesia, and Polynesia, the first wave or waves introducing the Austronesian language. Later

immigrants, before A.D. 450, came in large double sailing canoes and sailing canoes with single outrigger. These people ("Kava people") constituted the oldest ethnic stratum in western and central Polynesia, and through earlier mixture with Melanesians they brought with them some Melanesian physical and cultural traits. A later stream of Kava people brought the dug-out with added strakes, and were instrumental in raising Polynesian culture to its highest level. The authors consider that the migration of the "Betel people" into Melanesia was probably the last of the great movements, and it did not reach Polynesia. This, like the other migrations, they regard as probably coming from the Moluccas. Hawaii they believe to have been settled by the proto-Polynesians about A.D. 400–450, their route being a direct one through Micronesia. The authors conclude with a reference to the "few tentative efforts" they have made towards a solution of the complex problems of Oceanic ethnology and history, but future students in this field will have other views on the character of this invaluable monograph. H. S. H.

THE MEN AND BIRDS OF PARADISE: journeys through Equatorial New Guinea. By A. J. MARSHALL. *London: William Heinemann*, 1938. 9×5½ *inches;* xii+300 *pages; illustrations.* 15*s*

Mr. Marshall has followed up his 'Black musketeers' with another book in the same vein. This time it is not the saddening spectacle of a depopulated country that he surveys, but a paradise, as he calls it, inhabited by vigorous and abundant natives. The author went to the north of New Guinea to see something of the country in preparation for a proposed later expedition on a larger scale. In this preliminary walkabout he has already seen a good deal and penetrated into the Stone Age culture of the interior. He writes with vigour, and the interest of the narrative is maintained throughout. Mr. Marshall has a genuine gift for making personalities, both black and white, come alive for his readers. Some of the photographs are good, but many seem to be the result of substituting careless snaps with a modern miniature camera for really careful photography. His written descriptions of scenery are often excellent. Throughout the book the reader gets a vivid impression of what the author saw and thought. J. R. B.

POLAR REGIONS

"BIRDIE" BOWERS OF THE ANTARCTIC. By GEORGE SEAVER. *London: John Murray*, 1938. 8½×5½ *inches;* xxiv+270 *pages; illustrations and maps.* 10*s* 6*d*

The story of Captain Scott's last expedition has been told many times, but this book tells it from a new angle, in the form of a biography of H. R. Bowers. Biographies have already appeared of Oates, Scott, and Wilson, who were his companions on the journey to the Pole in 1912. The references to Bowers in Scott's journals and in Cherry-Garrard's 'The worst journey in the world' must have given to many a desire to know more about him, and now Mr. Seaver, Wilson's biographer, remedies this omission. A great deal of the book consists of excerpts from journals and personal letters written by Bowers to his mother and sister, for whom he had a deep affection. Mr. Seaver has wisely left these excerpts to speak for themselves and has fulfilled his task of putting in the connecting links with admirable skill.

Bowers's early life was marked by hard work rewarded with success. After leaving school, he went to H.M.S. *Worcester* to be trained for a life at sea. Having been appointed midshipman, R.N.R., Bowers left sail to gain experience in steam; and the following year he was gazetted to the Royal Indian Marine as sub-

lieutenant. Later he was appointed to H.M.S. *Fox* and spent an exciting year searching arms-carrying dhows in the Persian Gulf.

His appointment to the Antarctic Expedition came as a complete surprise, for he had made no direct application. Sir Clements Markham knew of his long-felt wish to go south, and his old captain on the *Worcester*, Sir David Wilson Barker, backed Sir Clements's recommendation with such vigour that the result was a telegram from Scott offering Bowers a place on the *Terra Nova* without an interview. It was primarily as junior ship's officer in charge of stores that he received his appointment. This was perhaps the most arduous, most thankless, most difficult, and yet most responsible task of all. But so thoroughly and systematically did he perform his duty that when the stores were eventually unloaded in the Antarctic, Scott was able to write "there is not a single case or a single article of any sort which he cannot put his hand on at once." His services in fact proved so invaluable that Scott decided to transfer him to the shore party. His cheerfulness and his astonishing energy for work of all types had made him one of the most useful members of the party. He was selected by Wilson to accompany him on the winter journey to Cape Crozier. From Bowers's own brief account one might suppose that this remarkable adventure was nothing very much out of the way. There are no new details to add to those of Wilson's official report, but possibly this reticence was due to a desire to spare his family anxiety.

Bowers's achievements on the Polar Plateau must rank as unique. It was decided only at the last moment that he should take part in the final effort to reach the Pole, and since he had then deposited his skis at the last depot he had to pull on foot between his four companions, who were on skis. He did this for 360 miles. Yet, in spite of the physical exhaustion which he must have felt, he willingly undertook the responsibility of looking after the stores and of keeping the meteorological log. Although this log was kept under extremely difficult conditions, we have Sir George Simpson's testimony that it was an almost perfect record. He was also navigator.

Scott's journal will remain the chief document of this epic story, but that of Bowers is well worthy of a place beside it. Bowers had more than physical strength. His religious beliefs were deep and sincere, and carried him through those last terrible days with undaunted courage. His journal and letters reveal also a power of descriptive writing which is rare in a man of such an essentially practical turn of mind. B. B. R.

PHYSICAL AND BIOLOGICAL GEOGRAPHY

BAUSTEINE ZU EINEM SYSTEM DER TEKTOGENESE. Bd. I. Periplutonische und enorogene Regionalmetamorphose in ihrer tektogenetischen Bedeutung. By FRANZ ED. SUESS. (Fortschritte der Geologie und Palaeontologie. Bd. XIII. Heft 42.) *Berlin: Borntraeger*, 1937. 10×6½ *inches;* viii+86 *pages; illustrations and sketch-maps. RM.*9

In this, the first of four essays, Professor F. E. Suess gives a synthesis of his ideas on tectonics and rock metamorphism.

A typical orogen is for him a threefold structure, consisting of foreland or unloaded zone, overridden or loaded zone, and overriding or loading segment of the earth's crust. Such an orogen—for instance the Alps—is interpreted as the effect of the drift of continental masses.

Professor Suess focuses attention on the metamorphic rocks which alone can reveal the nature of the processes actually at work deep down in the earth's crust. In an orogen it is especially the rocks within the loaded zone which suffer

metamorphism. In this zone the rocks are intensely deformed and recrystallized; alkalis are mobilized with characteristic mineralogical results; the recrystallization slows down gradually after the deformation ceases as the heat "dammed back" by the overriding segment is dissipated; thus "post-tectonic crystallization" is widespread. This type of metamorphism is distinguished as "enorogene Regionalmetamorphose."

With this enorogenic regional metamorphism Suess contrasts "periplutonische Regionalmetamorphose." This is essentially thermal, not deformative metamorphism, and is attributed to heat carried up by magma from deeper within the earth. This type of metamorphism is found not in the orogenic zones but independently, and is associated with a quite different kind of tectonics known as intrusion tectonics. Regions of intrusion tectonics show signs of irregular plastic deformation in contrast to the predominantly parallel structures of an orogen.

Intrusion tectonics and periplutonic regional metamorphism are thought to be widespread within the crust. The structures and metamorphism seen in many regions of Pre-Cambrian rocks, for instance Finland and South-West Africa, are interpreted as of this type, and not as the result of repeated or world-wide Pre-Cambrian orogenesis.

Much of the evidence on which Professor Suess bases his conclusions is given in his previous works on intrusion tectonics. Not all geologists will agree with these conclusions, but any one interested in the fundamental problems of the deformation of the earth's crust will find much of interest in this work, and will look forward to the appearance of the succeeding essays. R. M. S.

THE CALIFORNIA WOODPECKER AND I: a study in comparative zoölogy. By WILLIAM EMERSON RITTER. *Berkeley: University of California Press* (*London: Cambridge University Press*), 1938. 9½×6 *inches;* xiv+340 *pages; illustrations and maps.* 16*s*

This is a somewhat unusual work by a well-known Californian zoologist, formerly Professor of Zoology in the University of California and Director of the Scripps Marine Biological Laboratory at La Jolla in California. The first part is an intimate study of the Californian woodpecker, to which Dr. Ritter has devoted much attention for a good many years. This remarkable bird is illustrated by a coloured plate from a painting by Major Allan Brooks. It is known to ornithologists as *Balanosphyra formicivora bairdi*, and it inhabits the coastal districts of California and southern Oregon. Unlike most woodpeckers it lives chiefly on acorns, and differs from all other birds hitherto known in its habit of storing the acorns for winter use in neatly bored holes in the bark of one of the oak or other trees among which it lives. It is with the oaks that the woodpecker is chiefly associated; some nine species are found at various elevations, and the woodpeckers in groups of half a dozen or so inhabit a particular oak grove. The other remarkable feature of the behaviour of these birds is that they do not pair in the normal fashion, and the entire breeding operations, from excavating the nest cavity to the end of the feeding of the young, area communal affair participated in by several individuals, males and females, without any evidence of a mated pair.

Having given a detailed account of the various remarkable activities of his woodpeckers, Dr. Ritter compares them with other animals, and especially with himself as a representative of the human animal. He deals with mind, brain, and conduct, explaining how it is that birds have not reached the highest grades of intelligence owing to the poor development of the cerebrum as compared with the higher mammals, and specially with Dr. Ritter. Although much

of the matter is of a severely technical nature the language used is clear and simple, and there is a delightful absence of the use of technical terms. We can thoroughly recommend it as a most readable volume not only to ornithologists but to all interested in living creatures. W. L. S.

CARTOGRAPHY

RAND MCNALLY STANDARD ATLAS OF THE WORLD. *New York: Rand McNally*, 1938. 10½×7 *inches;* 382 *pages* (*incl. about* 172 *pages of maps*). $3

While this purports to be a world atlas, its main function is to provide a convenient atlas and gazetteer of the United States, which occupies a large proportion of the volume. The State maps are of varying scales, controlled by the page size, and the maps are almost exclusively political, with administrative boundaries reinforced in orange. Large water areas are tinted blue against a pale buff background. For relief a poor hachure system is adopted which, in an area like western Utah, is reminiscent of the "caterpillars" of last century. A valuable feature of the atlas is the amount of descriptive material, both verbal and photographic, ranging from concise but adequate accounts of each country of the world to a chronological review of the history of aviation and a list of voyages of discovery and exploration. The atlas as a whole represents a laborious gathering together of material, some of which is liable to be used less frequently than it merits, since it is unusual to obtain such information from an atlas.

A. C. O.

THE LIBRARY ATLAS. Edited by GEORGE PHILIP and H. C. DARBY. *London: George Philip and Son*, 1938. 15×11 *inches;* xvi+116 (*maps*)+36 (*index*) *pages*. 21*s*

The reissue of the "University Atlas" (*Geogr. J.* 90 (1937) 568) at twice its original price, with no other embellishments than twenty extra pages of commodity maps and a slightly more substantial cover, is perhaps a little surprising.

The maps in this commercial supplement however are interesting and well produced. Most of them show the distribution of agricultural and mineral production. Each commodity has a world distribution map and several larger-scale maps of the chief producing areas. The land areas are printed in pale yellow, and the dots usually in red or blue, so that the main facts of distribution stand out well. In addition there are divided-circle diagrams demonstrating the relative proportions of the main countries in world production.

In order to overcome the difficulty of showing concentrated production, solid squares as well as dots are employed quite effectively in some cases. As is usual with very small-scale world maps showing distributions, inaccurate and false impressions are frequently given, and for this reason the idea of having larger-scale insets of the chief areas was a happy one. Thus in the world map of wheat, not a single dot appears in East Anglia, though there are many in other parts of Britain; and in the world map of oats the British Isles are covered with a solid mass of colour. Some details might be criticized: the curious concentric distribution of dots in the state of Iowa in the maps on pp. 100 and 102; and the incorrect placing of the dots representing tobacco in Bulgaria on p. 105.

The mapping of mineral production is always a difficult task, since production from individual localities and not generally from widespread areas is dealt with, so that the dot method is seldom successful. In this atlas the dots frequently spread over a much larger area than the actual mining fields. This is especially noticeable in the maps of iron ores, where false impressions are given, for example, of the size of the ore-fields of Lorraine, Ukraine, northern Sweden,

and of Britain. In some cases, too, especially in the less well-known countries, the compilers are a little hazy as to the exact position of the resources: thus the chief coalfield of Bulgaria is marked as a "lesser working," and the coal-dots in this country are placed where no coal exists; and in Yugoslavia the two principal metalliferous mining centres, Bor and Trepča, are completely misplaced.

The maps of non-ferrous metallic wealth are the least successful. On p. 114 it is not made clear whether ores or metal are being dealt with. One assumes from the figures that it is metal, in which case the maps are not always correct, since smelting does not always take place on the ore-fields. If for example the map entitled "aluminium" really means metallic aluminium, it is incorrect and incomplete, since the smelters of Scandinavia and Scotland are not shown, and the bauxite fields are by no means all producers of metal.

Finally, the map showing water-power is rather artificial; no actual localities are recorded, and a table of statistics or a block diagram would have been quite as effective. S. H. B.

ECONOMIC AND HISTORICAL GEOGRAPHY

THE WORLD'S AIRWAYS. By ROBERT FINCH. *London: University of London Press*, 1938. 8×5 *inches; 224 pages; illustrations and maps.* 5*s*

This is a comprehensive summary of the activities of the air lines of all countries. Mr. Finch has amassed a large volume of information which he sets out simply and concisely. He begins with a short outline of the growth of aviation from its earliest days and touches on some of the difficulties experienced by the international air lines at present operating over foreign countries. Every aspect connected with the safe operation of aircraft when on the ground and when in the air is explained, but he is not so absorbed in his subject as to become involved in a mass of technicalities. Neither is it to be regretted that some two-thirds of the book centre round the activities of the air lines of the British Empire, and in particular of Imperial Airways.

Mr. Finch illustrates his book with some good photographs and with many small-scale maps showing the air routes in operation in each country. The book is written in a style which will appeal to the non-technical reader and to the younger generation. W. E. H.

THE VOYAGERS AND ELIZABETHAN DRAMA. By ROBERT RALSTON CAWLEY. Published by the Modern Language Association of America (Monograph Series VIII). *Boston [Mass.]: D. C. Heath and Co.—London: Oxford University Press*, 1938. 9½×6 *inches;* xiv+428 *pages.* 18*s*

The opening years of the seventeenth century marked a decisive stage in the development of English geographical literature, which is symbolized by the publication of Hakluyt's great collection. Narratives of English voyages and translations of foreign books provided a mass of more or less accurate information about distant countries, which superseded the traditional lore based largely upon classical sources. Professor Cawley, by industriously collecting and classifying geographically their references to foreign lands and peoples, shows how a somewhat similar development took place in the works of contemporary dramatists. Nevertheless, despite the clash of experience with tradition, the influence of the classical writers remained strong in the case of Africa and Asia, except for regions which had lain outside the classical sphere, and even in America marvels displaced by the spread of knowledge in the older hemisphere found a new home, to flourish mightily for many years. Their long life is no doubt attributable to the fact that the playwrights largely remained students of the classics first and geographers second, if at all.

In tracing the origin of the literary allusions, the author has limited his difficult task to indicating their sources in the printed works available to contemporaries. His work, which will be particularly useful to students of Elizabethan literature, illustrates strikingly the way in which the imagination of the dramatists, in search of similes and metaphors, seized upon the details of the narratives and embroidered upon them for their own purposes, and the delight they took in sonorous and exotic names. Whether it can be deduced from this particular evidence that there was a widespread "geographic conscience" is arguable; the playwrights at least impressed upon their public, more successfully perhaps than the serious propagandists, the existence of great new lands across the ocean. It is perhaps worthy of note that the most painstaking writers quoted frequently in this work are not dramatists, but prose writers, namely Francis Bacon and Sir Thomas Browne. Professor Cawley however promises a second volume in which the evidence here collected will be examined critically.

G. R. C.

GENERAL

WE SAILED FROM BRIXHAM. By Lieut.-Colonel CLAUDE BEDDINGTON. *London: Peter Davies*, [1938]. 9×5½ *inches; 302 pages; illustrations and route-charts. 12s 6d*

Two magnificent but not freak sailing-yacht cruises are the subject-matter of this entertaining book. They were not made in an ultra-small yacht nor with an impossibly small complement. The craft was of nearly 100 tons Thames Measurement and the crew and passengers numbered from ten to twelve at different times. The extreme ports of call on these cruises, made in the winters of 1935–36 and 1936–37, were 'Aqaba, at the head of the gulf of that name on the east side of the Sinai peninsula, and Duala, 27 miles up the Mungo river, Cameroons. Altogether a distance of 19,580 miles was covered, with only occasional use of auxiliary power; average speeds were astonishing. Colonel Beddington clearly loves the thrill of handling a sailing craft: he knew what he wanted in the way of a ship and got it, regardless of criticism. He shows that every criticism of a given rig or hull type or what not in the yacht-sailing fraternity can be placed on a balance-sheet whose *pros* and *cons* invariably tot up to zero: you can in fact go afloat in what you like because your ideals are not those of the critic. The author, then, not only decided to go to sea in a Brixham trawler but built one for himself.

Once started, Colonel Beddington does not dawdle, either on the sea or on the printed page. He takes us from Brixham to Vigo in a couple of pages. Somewhere between Greece and Malta the yacht ran into a gale of wind which reached hurricane force at times and lasted over forty-eight hours, and there is a good description of what really happens when such a craft lies to under storm conditions.

The recital of the numerous incidents of life at sea and ashore, the comments on men and things, the spotlights on political questions even, will all be enjoyed by the reader, the more so since they are all illuminated by an innate and not overworked sense of humour. The book has an abundance of photographs. Rough small-scale charts inside the covers, one for each cruise, to form ready references for the reader are most practical.

H. L. P. J.

THE MONTHLY RECORD

THE IRON AND STEEL INDUSTRY OF SCUNTHORPE

An interesting account of the development of the iron and steel industry of Scunthorpe was contributed by Mr. O. D. Kendall to *Economic Geography* for July 1938. The works are established on the western outcrop of the Frodingham ironstone beds, which here have an average thickness of 25 feet, and extend over an area of some 20 square miles, dipping to the east. Their composition is extremely variable: the ore content is low, from 20 to 25 per cent., and silica short, though lime is present in sufficient quantities. This variability caused many difficulties in the early days of the industry. The silica deficiency is now made good by stone from the Northampton and South Lincolnshire beds. The ore was first worked in 1859, being sent into Yorkshire for smelting, but a few years later companies were formed to smelt locally. For some time progress was slow. In 1890 basic iron for conversion into steel was produced, and the same year saw the beginnings of the steel industry. Since the War however development has been on a large scale: in 1936 the Frodingham area produced 13·3 per cent. of the United Kingdom output of iron, and 10 per cent. of the steel. Recently railway communications have been considerably improved, facilitating the transport of coal and coke from the South Yorkshire coalfield: the connections with the modern ports of Grimsby and Immingham, through which most of the steel is exported, are good, and the river Trent is to be used in the future. There are now no purely blast furnaces in the area: all are engaged in making steel and have rolling mills attached. A considerable amount of semi-finished steel is sent to other centres, especially South Wales.

Scunthorpe, which now has a population of over 40,000, is still dependent on one industry, but Mr. Kendall anticipates the establishment of subsidiary steel industries.

FIELD BOUNDARIES IN NORTH-WEST EUROPE

It appears that the hedgerows of the English countryside impress the German traveller as much as the open landscapes of Central Europe strike the Englishman. Herr Jessen, in "Heckenlandschaften im Nordwestlichen Europa" (*Mitt. geogr. Ges. Hamburg*, Bd. XLV, 1937), reviews the field boundaries of north-west Europe, where hedges, banks, stone walls, or ditches parcel out the countryside. The *bocage* regions are associated with the Atlantic type of climate, provided that there is sufficient shelter to allow tree growth. They form therefore a discontinuous belt, aligned N.E.–S.W., along the margin of the European continent from Denmark to Brittany, extending over the greater part of the British Isles and along the northern coast of the Iberian peninsula. The regions of most ancient enclosure are identified with the Celtic fringe of Europe, and small fields with their bounding stone walls or high hedge banks are common to Armorica, Devon–Cornwall, Wales, and Cumbria. In this connection there is an interesting reference to the survival of the system of "rundale" or "runrig," in the Lake District, West Scotland, and Ireland.

In the introduction the author states that he drew on material provided by the topographic maps of the various countries concerned, with the exception of the British Isles, where, finding the Ordnance Survey large-scale maps of no assistance in differentiating field boundaries, he turned to other (unspecified) sources. It is unfortunate therefore that the map of the British Isles is drawn on a smaller scale than the others, and that it is also inaccurate in detail. For example, a very wide belt of "ditch regions" is indicated in the Vale of York,

but Holderness, the north Norfolk coastal marshes and the Broads, together with Sedgemoor, are not thus delineated, and the stone walls of the Pennines are made to cover too restricted an area. The title of the map would have been improved by a translation other than the would-be helpful one of "fencing country." Nor does the map of north-west France reflect the text very closely, for the coastal platforms of Brittany are excluded from the *bocage* (p. 35), and only the *landes* of the Montagnes d'Arrée, the Montagne Noire, and Lanvaux are thus shown on the map.

The author draws the conclusion that there is a regional similarity between Devon with its hedgerows crowning deep-sunk lanes, Brittany with the pollarded oaks and elms of the *bocage*, Flanders with its poplar-bordered fields, north-west Germany with its *knicks* and fences, and eastern Denmark where hedge banks give a chequer-board effect to the landscape. It is evident that the individuality of such *pays d'enclos* is also qualified by diversity, according to the nature of the locality. A. F. A. M.

THE *BOLLETTINO* OF THE ROYAL ITALIAN GEOGRAPHICAL SOCIETY

With the January number, the *Bollettino* of the Royal Italian Geographical Society appears in a more attractive form. The type and the general style of production have been improved, and the illustrations are increased in number. The intention is to give the publication a wider appeal, and it is to be put on sale to the public with a different cover and the title "Paesi del Mondo." The change is reflected also to some extent in the contents. Future policy is briefly outlined in a foreword by Sig. Giuseppe Bottai: the diffusion of an accurate knowledge of the world, a reconciliation between the scientific and the human approaches, and the recognition of geography as a pivotal study for a modern nation. Professor E. Migliorini, in a review of the present position of geographical studies in Italy, shows that geography has in the past been relegated to an indeterminate place in the faculties of arts, with the result that too much attention has perhaps been given to the historical aspect. He points out also that until recently work in the field, particularly overseas, has been neglected, and that comprehensive studies of Italian regions on the lines of the French school are required. An article by Alberto de Agostini summarizes the results of his explorations in the southern Patagonian Cordillera in the years 1933–35.

THE ECONOMIC HISTORY OF BRAZIL

Our attention has been drawn to two statements in the review of Dr. R. C. Simonsen's 'Historia economica do Brasil' which appeared in the *Journal* for July 1938 (p. 81). In his remarks about "the famous book of Pero Magalhães de Gandavo," the reviewer has overlooked the fact that Gandavo was the author of two works: the 'Tratado da Terra do Brasil' was written about 1570, but was not printed until 1826; the 'Historia da Provincia de Santa Cruz' was published at Lisbon in 1576. The passage in Dr. Simonsen's book referred to the 'Tratado' and not to the 'Historia.'

The reviewer also stated "the author seems to imply that the clove (*Eugenia* sp.) is a native plant of Brazil." Dr. Simonsen did not affirm that the clove to which the reviewer refers was found in Brazil. The Portuguese in Brazil were constantly searching for spices, and the existence of the clove was reported from time to time. In the official list supplied to Andre Vidal de Negreiros, Governor of the State of Maranhão, in 1655, there is special reference to the search for clove and nutmeg. Large quantities of cinnamon were apparently obtained in the Tocantins in 1659. The wild clove also seems to have been found, as several royal letters recommended its cultivation round the villages.

THE NORTHERN TERRITORY OF AUSTRALIA

We have recently received through the courtesy of the High Commissioner a copy of the Report of the Board appointed in 1937 to inquire into the land and land industries of the Northern Territory. They were to examine particularly land tenures and the conditions of settlement, the best methods for encouraging ranching and agriculture, capital investment, marketing, and transport. The general attitude taken by the Board was to regard the Territory as being still in the pioneering stage, and its future an "All Australian" concern. It should therefore be entitled to freedom from some of the financial burdens borne by the States, and to special encouragement in certain necessary developments. It is recommended that no income tax, federal or territorial, should be levied for twenty years, that tariffs on incoming goods should be suspended, and foodstuffs allowed to enter from the States at export parity. The other main proposals are directed to assisting the pastoralists to establish themselves firmly, particularly by encouraging them to turn from cattle ranching to sheep farming in suitable areas. At present about one-third only of the Territory is held on pastoral leases. They consider that three areas should prove successful sheep country, the Barkly Tableland, the Alice Springs District, and the Victoria river or North-West District. For this purpose the provision of rail transport is imperative, and they recommend the extension of the Queensland railway from Dajarra a distance of 240 miles to the north of the Rankine river, and the building of a line from Wyndham 200 miles down the Ord river. They condemn strongly any idea of completing the Transcontinental line from Alice Springs to Birdum, as they hold that north to south communication is unjustifiable economically. In order to assist settlement they propose to abolish the petrol tax. As an example of the high cost of transport, they quote the price of flour, which at Brisbane is approximately £13 10*s*. a ton, and at a station in the Victoria River District £37. Various suggestions are made to aid pastoral development: the removal of uncertainty as to boundaries, assistance in improving water supplies and fencing, government advances at low rates in place of subsidies for improvements. They estimate that the Alice Springs District may eventually carry 100,000 cattle and 300,000 sheep; and the other two sheep areas a million sheep each.

In other directions they suggest that with the concessions recommended considerable mining development may be expected in the mineral belt south-east of Darwin. Closer settlement through mixed farming or agriculture is not anticipated. To improve the life of the white population in the tropics, they direct attention to the need for improved housing, and suggest, though approving of the White Australia policy, that a limited number of Chinese might be admitted as market gardeners to provide the necessary green vegetables and as indentured labourers to undertake housework.

The tax concessions urged would amount to a comparatively small sum annually, the principal charges would be incurred for railway building, though they hope that this would be recovered ultimately. It is recalled that during the twenty-six years of Commonwealth administration the total expenditure has exceeded £15 million. The Board hold no extravagant views as to the result of their proposals on the growth of population, anticipating a white population of 15,000 in ten years, and 40,000 in twenty-five years, as against a present European population of 3800.

PITCAIRN ISLAND

The Colonial Office have recently issued a report by Mr. J. S. Neill and Dr. Duncan Cook on their visit to Pitcairn Island in 1937, in which they discuss the

administrative, social, and health conditions of the islanders. The population, which now numbers 209, is remarkably strong and healthy, apart from the early loss of teeth, which is attributed to diet rather than to inbreeding, aswas formerly supposed. Since 1858, 122 deaths have occurred, of which the high proportion of 23 were accidental. It is emphasized that the large number of ships now calling at the island have disturbed its economy, the islanders relying upon exchanging easily produced fruits and curios rather than on more strenuous labour on their land. Proper cultivation of the soil is unknown: partly through their religious beliefs, they have neglected the provision of fresh animal foods, and some attention to the preservation of the soil fertility is necessary. The ravages of goats and extensive cutting for firewood have led to soil erosion. Practically the sole export is oranges to New Zealand, and this is hindered by storms and the uncertainty of transport. Improvement of the landing at Bounty Bay would, if practicable, be exceedingly costly.

The sanitary conditions are in general adequate, and the village of Adamstown is described as a "model of neatness." The water supply however, gathered in stone cisterns from the corrugated iron roofs, is liable to contamination, and breeds day-biting mosquitoes. Rats are also the cause of much loss.

Apart from epidemics mainly of a catarrhal nature, dysentery appears to be the commonest illness. There were no signs of hookworm infection. The decline in the high rate of natural increase is attributed mainly to changes in the age structure of the population, and in social outlook. The fact to which the investigators attach most importance is the cultural decline, particularly evidenced in the low standard of education and the domestic arts, and the decline of family influence. The schooling provided is inefficient and, being conducted in the island dialect, is contributing to the cultural decline. The annual income is estimated to be between £1800 and £2000. Though the islanders contribute to missionary work abroad, they seem unwilling to pay for their own requirements. The creation of a Pitcairn fund is therefore recommended, formed by a tax of £1 per annum on each household and the issue of postage stamps: it should be devoted first to the maintenance, in cooperation with the missionary body, of a properly trained teacher and a public health nurse. Some small alterations in the administration without destroying its present voluntary character, and closer contact with the High Commissioner of the Western Pacific, are also recommended.

STUDY OF CREOLE DIALECTS

We have had an inquiry from Mr. J. E. Reinecke, of Honolulu, for information about dialects and trade jargons (using the latter word in the sense of "pidgin") such as arise on cultural frontiers. Mr. Reinecke is engaged on a study of the sociology of these dialects, in the formation and nature of which little popular interest has been shown, except where European creole dialects are concerned. In the search for information he has been through the files of linguistic and anthropological journals, and much of the literature dealing with European creole dialects; references to obscure periodicals and other literature, as well as unpublished information on non-European jargons, their location, development, and functions, would be welcome.

OBITUARY

BRIGADIER-GENERAL M. E. WILLOUGHBY, C.B., C.S.I., C.M.G.

General Willoughby, whose death took place on February 14 last, was the only son of the late Lieut.-General M. W. Willoughby, C.S.I., and was born in 1864, being educated at Winchester and Sandhurst. He was posted to the Northumberland Fusiliers, later transferring to the 2nd Lancers (Gardner's Horse). He commanded the latter in 1913, and to the end his interest in it never flagged.

His war services included the Chin Lushai Expedition 1889–90, and China 1900 as Special Service Officer; in the Great War he served in France with the Indian Cavalry Corps, in Mesopotamia with the 7th Division, and later with the 3rd Indian Army Corps; and lastly in the Afghan War, 1919. He was mentioned in despatches five times.

He received the C.M.G. in 1914, the C.B. in 1918, and the C.S.I. in 1920, also the Russian Order of St. Anne, and retired in 1920. He had been a Fellow of the Society since 1901, and served on the Council from 1935 to 1938.

Apart from his profession, General Willoughby's interest lay in travel. As Military Attaché at Peking he was able to travel widely in China, and in fact visited all the provinces of that country except two during the period he held that post. This was one of the happiest times of his life, and he was never tired of recounting his many experiences there. His knowledge of the language enabled him to appreciate the feelings and understand the customs of the Chinese, which they quickly realized and reciprocated. After his retirement, he was able to visit other countries which he had not previously seen. He travelled through Africa from south to north, went to Australia and New Zealand returning *via* Canada, and to South America. He was always willing to lecture and recount his experiences, and took great trouble to read up all the history of the places in question beforehand, irrespective of whom his audience might consist. His addresses were interesting, full of humour and personal incidents. He was a good draftsman, and his pencil drawings and water-colour sketches considerably added to the value of his letters and lectures. Latterly ill-health curtailed his activities, but he still retained great interest in current affairs.

E. S. J. A.

PROFESSOR GUSTAV HELLMANN

The death of Dr. Gustav Hellmann on February 10 deprives the Society of a distinguished Honorary Member. Dr. Hellmann was born in Silesia in 1854 and educated at the University of Göttingen. His whole life was spent in the service of the Prussian Meteorological Institute, a body nearly equivalent to our Meteorological Office. He was Director of the Institute at Potsdam for fifteen years, and also Professor of Meteorology in the University of Berlin. Professor Hellmann's work was mainly climatological, and climatology is a department dependent quite as much on geography as on meteorology. He was four times President of the Berlin Geographical Society between 1901 and 1918, and he kept in touch with geographical work in all parts of the globe. He was a remarkable linguist and able to take part in the deliberations of foreign societies and international congresses with the ease and assurance of a native of the place of meeting. While much of his work was necessarily administrative, he was the author of many valuable papers, including descriptions of meteorological instruments and methods of his own devising, and the working up of climatological data. He was the leading exponent on the continent of the cartographic

method of discussing the distribution of rainfall, and for this purpose he was able to secure the placing of rain-gauges over the country with much more uniformity than the voluntary character of the British Rainfall Organization made possible over here, thus largely overcoming the disadvantages of a less numerous body of observers.

Professor Hellmann produced a fine series of average rainfall maps for the provinces of North Germany, but perhaps his most valuable researches were those which included the comprehensive discussion of floods in the Oder valley. The importance of this justified the long notice given to it in the *Journal* for December 1911. H. R. M.

FRANK HULME MELLAND

Mr. F H. Melland, who was accidentally killed on February 3, had served twenty-six years as an administrative officer in Northern Rhodesia. During this service he acquired an extensive knowledge of the country and an insight into the mentality and outlook of the native peoples, being in particular a keen student of native witchcraft. His experiences are recorded in his books, 'In witch-bound Africa,' and 'African dilemma,' written in collaboration with Mr. Cullen Young. In 1910, in company with his colleague, Mr. E. H. Cholmeley, he travelled on foot and bicycle from Rhodesia to Cairo, a journey which is described in 'Through the heart of Africa.' On his retirement Mr. Melland worked in London, on the staff of the Eastern African Dependencies' Office, and as a journalist. He was a member of council of the Royal African Society, and had been appointed Secretary a month before his death. He was for some years a Fellow of our Society, contributing papers on Northern Rhodesia to the *Journal*, and in 1922 received the Cuthbert Peek Award.

MEETINGS: SESSION 1938–39

Ninth Evening Meeting, 6 March 1939. Professor Kenneth Mason, Vice-President, in the Chair

Elections: John Chrysostom Deeney; Miss Dorothy Joan Freeman; John Knapp, R.A.; E. D. W. Leaf; Frederick Paddock; R. C. Barrington Partridge, F.R.HIST.S.; Miss Lillie Agnes Spencer, B.A.; Marshall Macdonald Spencer; Arthur Stanley Tribe, M.I.EX.

Paper: The British Expedition to Ellesmere Land, 1937–38. By Mr. David Haig-Thomas

Fifth Afternoon Meeting, 13 March 1939. Professor Kenneth Mason, Vice-President, in the Chair

Paper: Discussion on the Highway Development Survey. Opened by Sir Charles Bressey

Tenth Evening Meeting, 13 March 1939. The President in the Chair

Elections: Lieut. Robert Heberden Barber; Professor T. Graham Brown, D.SC., M.D., F.R.S.; Walter Douglas Cain; C. T. W. Curle; Miss M. D. Emmens; Thomas Courtenay Fooks; Captain Perceval Mills Cobham Hayman, F.Z.S.; Mrs. John Liddell; Miss Dorothy G. Lloyd; Lieut.-Col. R. C. McWatters, I.M.S.; Donald Ferguson Thomson, D.SC.; Robert Lawson Thomson; Miss Cynthia Beryl White

Paper: A journey in Dutch Guiana. By Mr. Ivan Sanderson

25°
E
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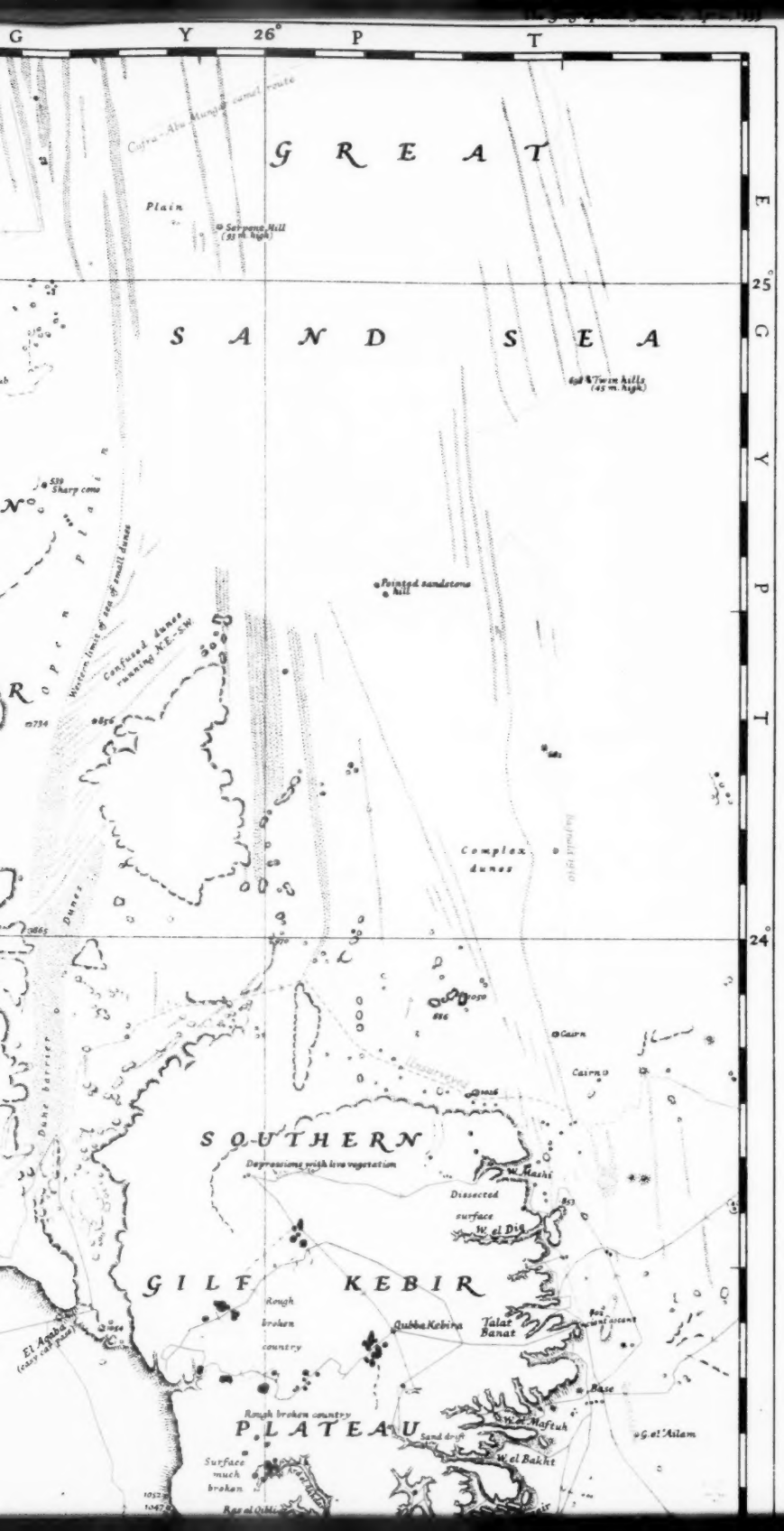
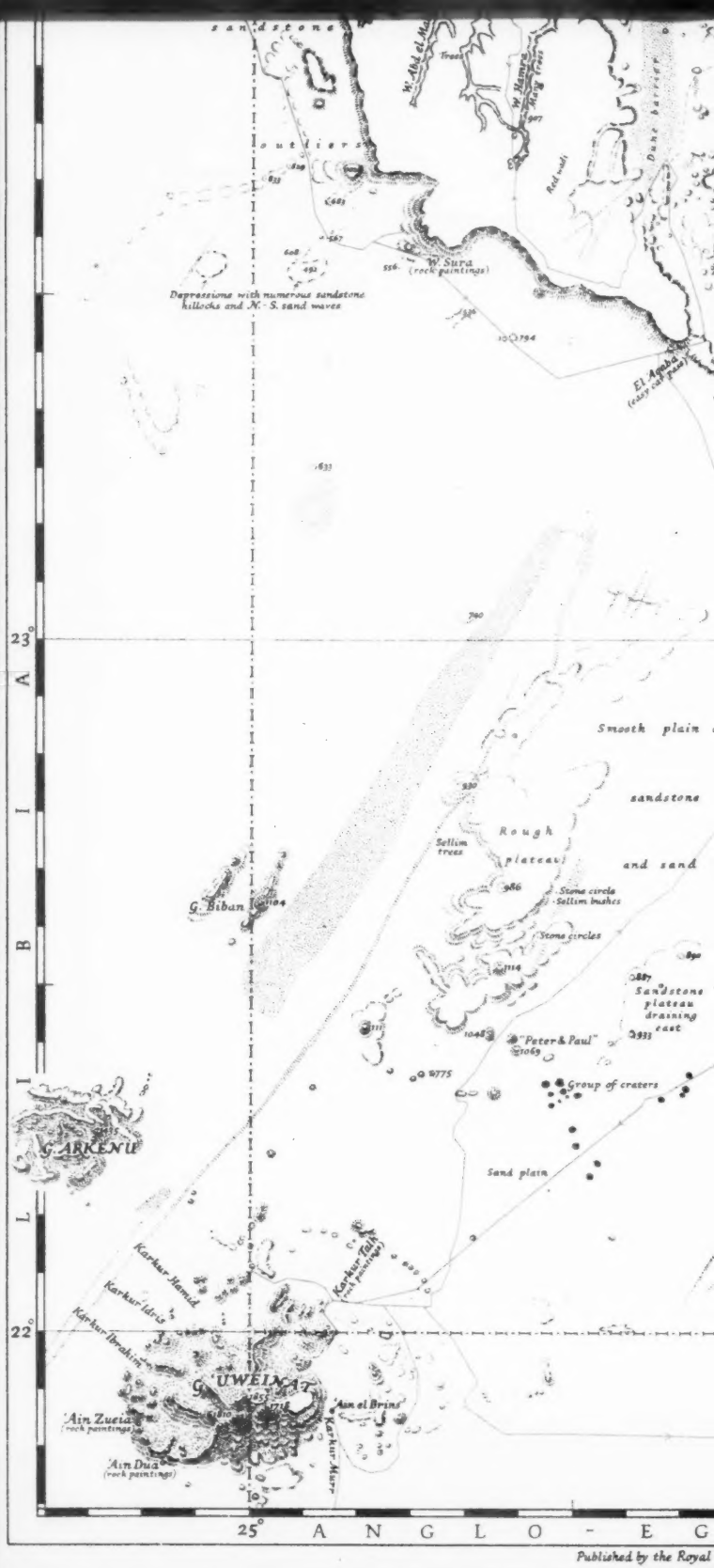
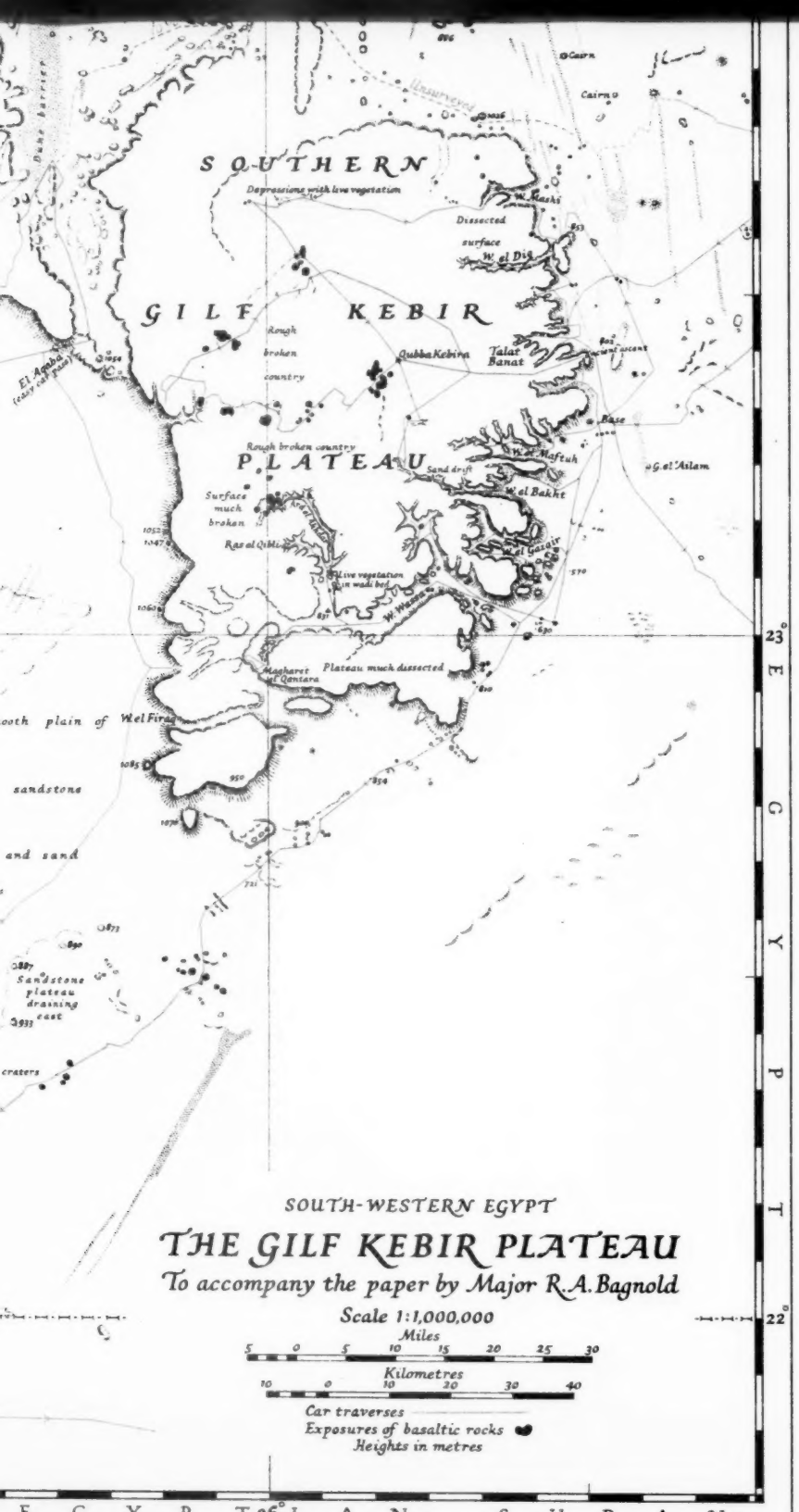
25°
24°
Rough stony plateau
W. el Gubba
Major Rolle's cairn
Sandstone outliers
Scrub
Many flat-topped sandstone outliers
NORTHERN
Sharp cone
Sand barrier in wadi
Sand
Sellim
Sellim bushes
Mud-pan with vegetation and implements
GILF KEBIR
Sellim
m734
Many Trees
W. Talh
Plain
PLATEAU
flat-topped
Sandstone
Dunes
plain
sandstone
W. Abd el Malik
Trees
W. Hamra
Rocky Hills
outliers
Dune barrier
Red wadi
W. Sura
(rock paintings)
Depressions with numerous sandstone hillocks and N.-S. sand waves
El Agaba
(easy car pass)
633


G Y 26° P T
GREAT
SAND SEA
Plain
Serpent Hill (35 m. high)
Twin hills (45 m. high)
Sharp cone
Pointed sandstone hill
Western limit of sea of small dunes
Confused dunes running N.E.-S.W.
Complex dunes
Dunes
Dune barrier
Cairn
Cairn
SOUTHERN
GILF KEBIR
PLATEAU
Depressions with live vegetation
W. Kashi
Dissected surface
W. el Dis
Rough broken country
Qubba Kebira
Talat Banat
Rock outcrop
Base
W. el Maftuh
Sand drift
W. el Bakht
G. el 'Aslam
Surface much broken
Rough broken country
El Agaba (easy rock pass)
Ras el Qibli
E G Y P T
25°
24°


sandstone
outliers
W. Abd el Mu'ti
Tree
W. Mamra
Mamra Tract
Dune barrier
Red soil
W. Sura
(rock paintings)
Depressions with numerous sandstone hillocks and N.-S. sand waves
El Arbaa
(coast-guard post)
23°
Smooth plain
sandstone
Rough
plateau
and sand
Sellim trees
Sellim bushes
Stone circle
Stone circles
G. Biban
Sandstone plateau draining east
"Peter & Paul"
Group of craters
G. ARKENU
Sand plain
Karkur Hamid
Karkur Idris
Karkur Ibrahim
Karkur Talh
(rock paintings)
22°
'UWEINAT
'Ain el Brins
'Ain Zueina
(rock paintings)
'Ain Dua
(rock paintings)
Karkur Murr
25°
A N G L O - E G
Published by the Royal



SOUTH-WESTERN EGYPT

THE GILF KEBIR PLATEAU

To accompany the paper by Major R. A. Bagnold

Scale 1:1,000,000

Miles 5 0 5 10 15 20 25 30

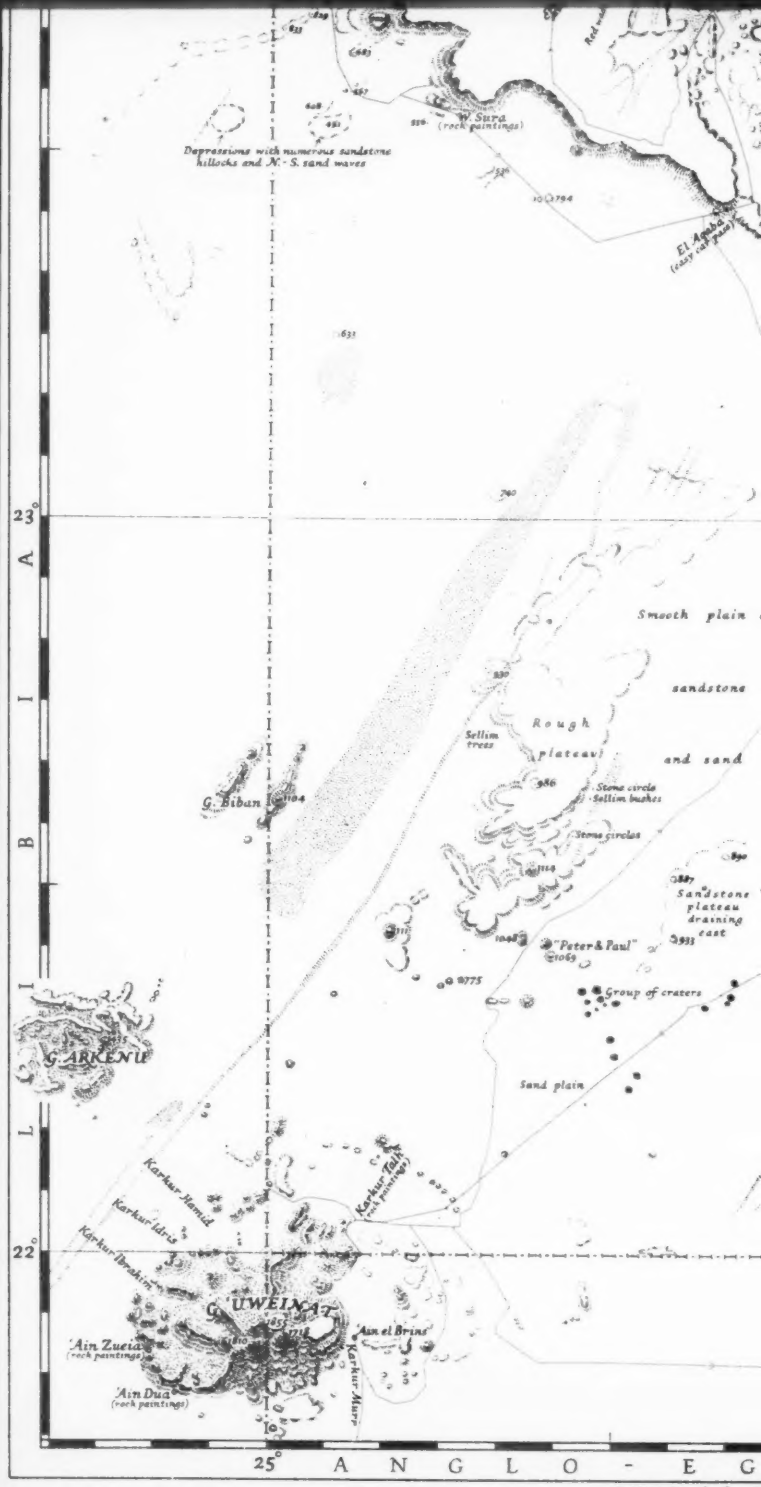
Kilometres 10 0 10 20 30 40

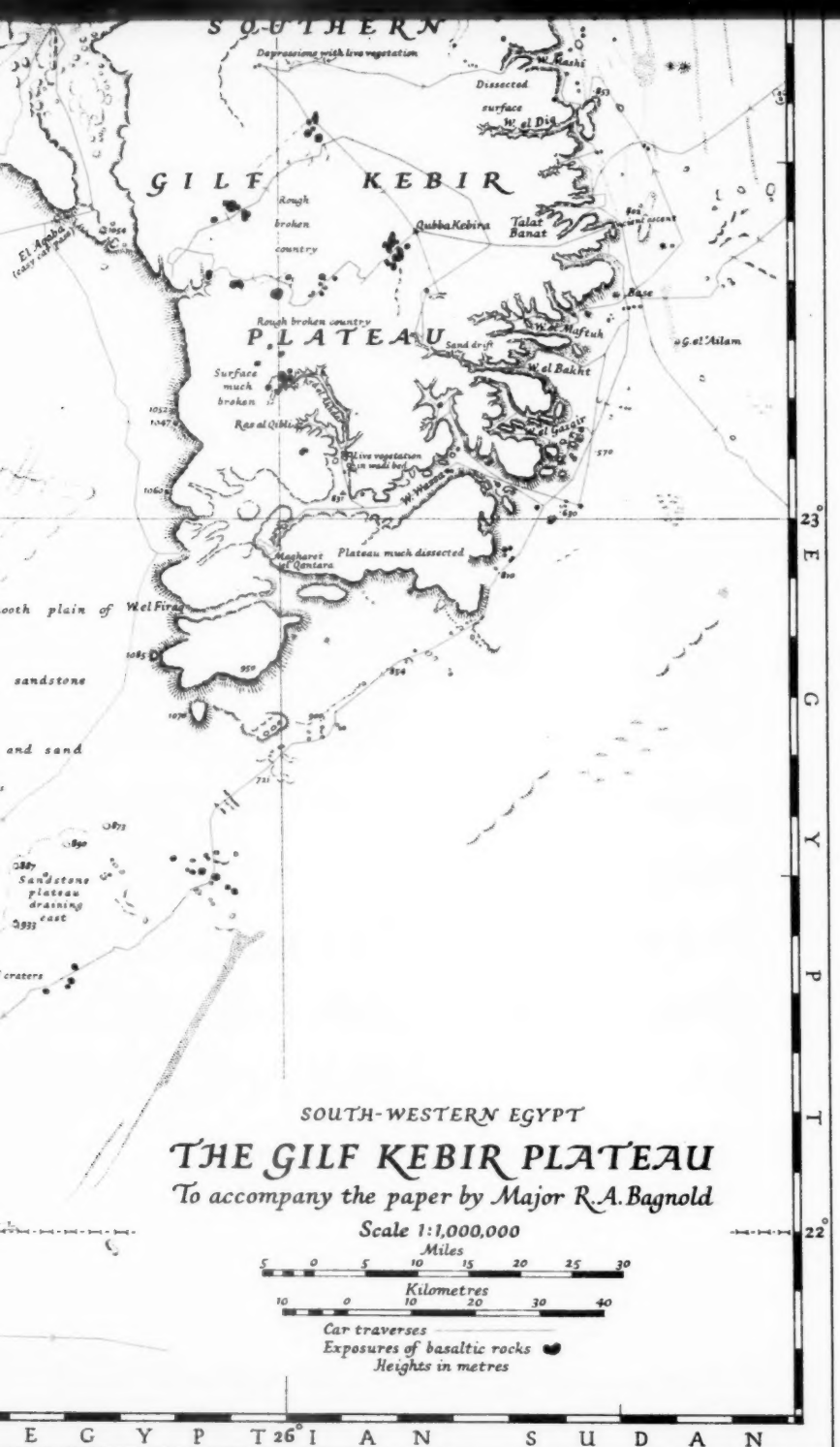
Car traverses

Exposures of basaltic rocks

Heights in metres

d by the Royal Geographical Society


Depressions with numerous sandstone hillocks and N.-S. sand waves
W. Sura (rock paintings)
El Agaba (easy salt pass)
Smooth plain
sandstone
Rough plateau
and sand
Sellim trees
Stone circle
Sellim bushes
Stone circles
G. Biban
Sandstone plateau draining east
"Peter & Paul"
Group of craters
G. ARKENU
Sand plain
Karkur Talh (rock paintings)
Karkur Hamid
Karkur Idris
Karkur Ibrahim
G. UWEINAT
'Ain el Brins
'Ain Zueia (rock paintings)
'Ain Dua (rock paintings)
Karkur Murr
23°
22°
25°
A N G L O - E G
Published by the Royal



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GILF KEBIR PLATEAU
Bagnold